Agrichemical use and safety

Master Gardener Fall Training Series 2023

Oregon State University
Extension Service
Douglas County

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Disclaimer

- OSU Extension Service does not endorse or recommend the use of any of the products listed or mentioned in this module.
- Product trade names are listed purely to provide examples of certain types of pesticides that you may come across in your home and garden store.
- The information in this presentation shouldn't be regarded as a substitute for professional consultation.

2

Why should I care about pesticides?

- A pesticide may be the best or only choice
- Pesticides can be used to avoid worse problems
- Making informed management choices
- Knowing how handle and dispose of pesticides safely increases efficacy and decreases mystery around pesticides

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Before Using Pesticides

- IPM steps review:
  - Scout your plants
  - Identify the problem
  - Establish an injury threshold
  - Evaluate appropriate management steps
  - Manage using all available strategies
    - Cultural control
    - Physical control
    - Biological control
    - Chemical control
      (In this order!)

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Pesticide Recommendations - OSU policy

- Oregon State University Extension Service encourages **Sustainable Gardening** practices.
  - Always identify and monitor problems before acting
  - Then consider **cultural** controls
  - Then **physical** controls
  - Then **biological** controls
  - And finally **chemical** controls (always consider the least toxic approach first)
- *How would you describe this approach to pest management? Integrated*

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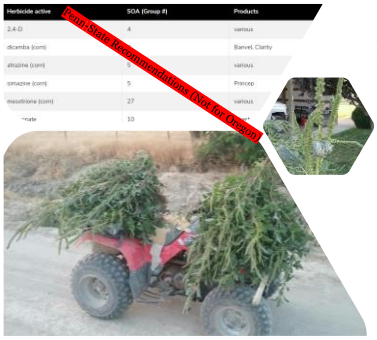
What is a pest?

Pests can be
- insects
- birds, deer and other animals
- unwanted plants (weeds)
- microorganisms (fungi, bacteria and viruses)

Pests are living organisms out of place.

6



Example:

Pigweed (Amaranth)

- Highly invasive in cropping systems
- Family in known to take over entire fields
- Elaborate tank mixes commonly used to spray it out

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Pigweed (Amaranth)

- Some species/varieties edible
- $9-10/lb
- Traditional food source in some places

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What is a pesticide?

US Environmental Protection Agency definition

A pesticide is:

- Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.
- Any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) of 1947

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History of pesticides

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The Etymology of Pesticides

Insecticide — 1865 (Paris Green)

Herbicide — 1888

Fungicide — 1889 (Bordeaux Mixture)

Pesticide — 1939

(from etymonline.com)

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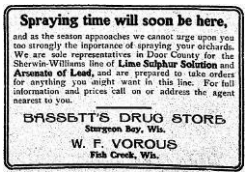
The Original Rogue Valley Golf Course—1911

The names for the nine holes with the bogies have been selected as follows:

Hole	Name	Bogy
1	Wooly Aphis	5
2	Thrips	5
3	Anthracnose	5
4	Blight	4
5	Scale	4
6	Slug	6
7	Borer	5
8	Blistermite	5
9	Codling	4

From: Medford Sun, 30 June 1911, p. 1:3.

12



Ad for Sherwin-Williams pesticides from the 1911 Door County Democrat. Today, about 3.9% of the land in the county is classified as "impaired" by the local government due to persistent contamination of the soil and groundwater.

[from Wikipedia]

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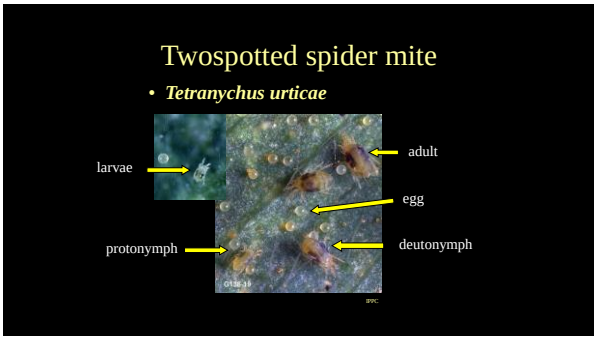

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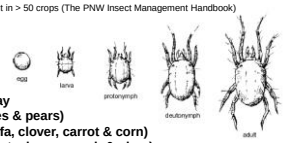
Spider Mites — Pest Status

Listed as a pest in > 50 crops (The PNW Insect Management Handbook)

- **Mint**
- **Hops**
- **Grapes**
- **Hazelnuts**
- **Christmas trees**
- **Timothy grass hay**
- **Pome fruit (apples & pears)**
- **Seed crops (alfalfa, clover, carrot & corn)**
- **Stone fruit (apricot, cherry, peach & plum)**
- **Various ornamental, nursery & landscape plants**
- **Vegetable crops (beans, beets, cucumber, potato, squash, etc.)**
- **Berry crops (strawberries, caneberries, currants & gooseberries)**



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Synthetic Insecticides
broad spectrum neurotoxins

Organochlorines (DDT, chlordane)

Organophosphates (parathion, chlorpyrifos)

Carbamates (carbaryl, aldicarb)

Pyrethroids (permethrin, deltamethrin)

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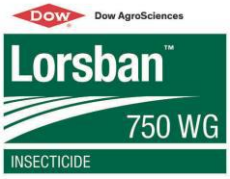
1972

1988



2021 (for food crops)

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Supervised Control

Integrated Control

Integrated Pest Management

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Integrated Control

First use in print: Michelbacher & Bacon. 1952. Walnut insect and spider mite control in Northern California. *JEE* 38:129-30

Concept is developed: Smith & Allen. 1954. Insect control and the balance of nature. *Sci. Am.* 190(6):38-92

Seminal article: Stern, Smith, van den Bosch & Hagen. 1959. The integrated control concept. *Hilgardia* 29: 81-101

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TREE FRUIT IPM IN SOUTHERN OREGON — PETER WESTIGARD

CLASSIC STUDY IN IPM

LEFT A BLOCK UNSPRAYED FOR 10 YEARS—1962-71

TREATED WITH NORMAL HORTICULTURAL PRACTICES

ANNUAL PESTS	MINOR PESTS	INDUCED PESTS
CODLING MOTH	LEAFROLLERS	PEAR PSYLLA
SAN JOSE SCALE	TRUE BUGS	SPIDER MITES
PEAR RUST MITE	(e.g. LYGUS)	

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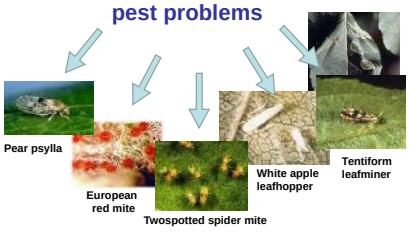
Disruption of naturally occurring biological control leads to secondary pest problems



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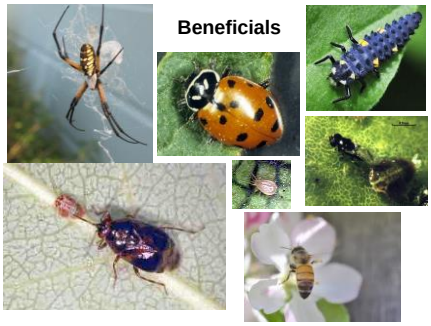
Beneficials



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Three Eras of the Insecticidal Age

- **Pre-Synthetic Era (1865-1945)**
  Inorganic compounds: Paris green, lead arsenate, sulfur; Oils; Soaps; Botanicals
- **Broad Spectrum Era (1945-current)**
  Synthetic broad spectrum neurotoxins: organochlorines, organophosphates, carbamates, pyrethroids, neonicotinoids
- **Selective Era (current-future)**
  New chemistries: selective neurotoxins, metabolic poisons, insect growth regulators; Microbials; GMOs; Behavioral methods

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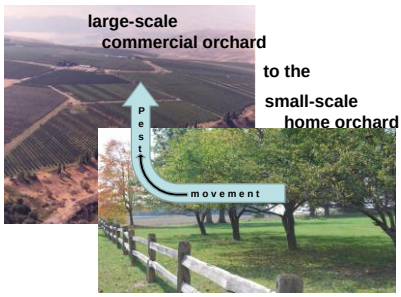
From the large-scale commercial orchard to the small-scale home orchard



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Understanding pesticides today

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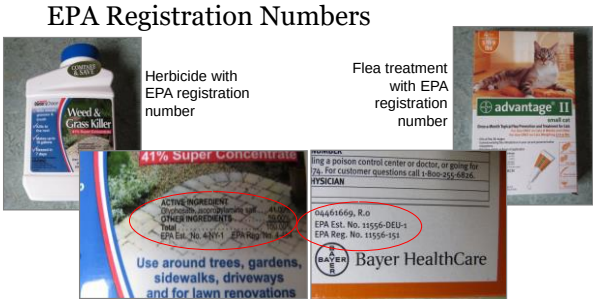
EPA Registration Numbers



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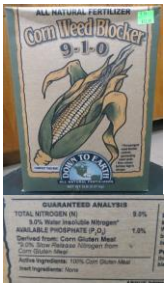
What is not regulated?

- Adjuvants
- Minimum Risk Pesticides
  - No EPA registration number
  - Must be labeled with
    - Name and weight percent of each active ingredient
    - Name of each inert ingredient
    - Examples: aromatic oils, corn gluten meal, putrescent whole egg solids, citronella



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Types of pesticides

- **ALL of these are PESTICIDES**
- **"cide" means "kill"**

- Acaricides/Miticides
- Bactericides
- Fungicides
- Herbicides
- Plant Growth Regulators (PGRs)
- Insecticides
- Larvicides
- Molluscicides
- Nematicides
- Rodenticides
- Scalecides

also

- Repellents

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What is not a pesticide?

- Drugs used to control diseases of humans or animals
  - (U.S. Food and Drug Administration)
- Fertilizers, nutrients, and other substances used to promote
  - plant survival and health
- Biological control agents (except some microorganisms)
  - includes beneficial insects that eat insect pests.)
- Products which do not have to be registered as pesticides, as they contain certain low-risk ingredients:(for a complete list see FIFRA Sec. 152.25 (g))
  - citronella
  - citric acid
  - corn gluten meal
  - garlic and garlic oil
  - mint and mint oil
  - rosemary and rosemary oil
  - thyme and thyme oil
  - zinc metal strips

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Pesticide Use in Perspective

- USA: 74-90% of households utilize pesticides on an annual basis (Whitmore et al. 1994; Landrigran et al. 1999, Fishel 2007)
- Oregon: 46% of households used pesticides in 2007 (PURS 2008)
- Portland Metro: 29% of households used lawn and garden pesticides and 17% used indoor pesticides (Peters et al. 2007)

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Oregonians using pesticides?

- Pesticide use is generally underreported, and risk perception is generally underestimated (Nieuwenhuijse et al. 2005)
- PURS (Oregon's Pesticide Use Reporting System)
  - Survey "*participants were unable to determine what products were pesticides*"
  - "*continued concerns about the ability of pesticide users to read the label and correctly identify information*"
  - "*Moss control products accounted for 47% of the pounds of active ingredient, but only 2% of the reports identified moss control as the purpose*"

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Why Learn About Pesticides?

- Educate growers so they can choose wisely
- A pesticide may be the best or only choice
- Holistic view of all options
- Provide information that is descriptive, not prescriptive
- Safe handling and disposal
- DON'T calculate application rates for growers– Send them to the appropriate extension agent

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Pesticide Formulations

The formulation describes the physical state of a pesticide product. It is comprised of:

- **active ingredients**(s) (ai)
- solvent
- dry carrier } "Inert" ingredients
- adjuvant

The formulation of a pesticide can have significant implications for safety and effective use

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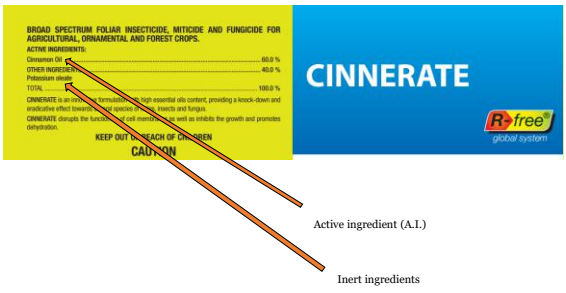

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Pesticide Formulations

Liquids
- ✓Emulsifiable concentrate (EC)
- ✓Solution (S)
- ✓Flowable (F)
- ✓Aerosols

Solids
- ✓Dust (D)
- ✓Pelletized bait
- ✓Flowable (F)
- ✓Granule (G)
- ✓Wettable powder (WP)
- ✓Soluble powder (SP)
- ✓Water Dispersal Granule (WG-WDG)

Others?
Ready to Use (RTU)

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Ready-to-Use vs. Concentrate

Pesticides that are pre-mixed or packaged in containers that double as applicators.
- Fewer steps
- No measuring and mixing
- Less chance of mistakes

Pesticides that must be measured and mixed by user
- Better for larger areas

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Different Packaging

These all have the same active ingredient, but (from left to right) one is Ready to Spray (attach to a hose), one is a liquid concentrate, and one is Ready to Use.

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Pesticide Terminology

- Commercial / Home use
- Hard/Soft
- Organic / Synthetic
- Broad / Narrow spectrum (Non-selective/Selective)
- Short term / Residual
- Contact / Systemic
- Curative / Protectant
- Pre-emergent / Post-emergent

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Mode of Action

- Contact
  - pesticide must be sprayed directly on the target (weed, disease, insect, etc.).
- Systemic
  - pesticide can be translocated throughout the target plant to either protect it (fungicides, insecticides) or kill it (herbicides).
- Residual
  - pesticide will persist after application, offering control for a period of time (Casoron, *B. t*).

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Pre-emergent vs. Post-emergent

- Applied prior to seedling emergence
- Prevents germination of seeds
- Can be applied over entire site before crop is seeded or plants planted
- Can be applied around perennial plants to prevent annual seedlings

- Applied after seedling emergence (weeds *or* plants)
- Controls actively growing plants
- Needs careful application
  - Roundup™ (a.i. glyphosate)

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Curative vs. Protectant

- Corrects existing problem - can kill target pests if present
  - Quintec (quinoxyfen)

- Prevents problem from occurring - protects healthy plant parts from attack by pest organisms
  - Micronized Sulfur

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Mode of Action

- Non-selective
  - provides broad-spectrum control of pest organisms (i.e. Roundup)
- Selective
  - targets specific organisms while doing no harm to many other organisms that may be present (i.e. Weedar 64).

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Contact Herbicide: Caprylic acid and Capric acid (OMR

- Fatty-chain acids
- In high enough concentration to be damaging to plants and to humans (44% Caprylic, 36% Capric for HomePlate® herbicide)
- Burn Down, post emergent
- Causes Leakage and desiccation of cells
- Can damage some hardier plants (e.g., Purslane)

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Commercial & vs. Home

Restricted Use Pesticides (RUPs)

- May be packaged in large quantities

General/Home Use Pesticides

- Not designated as RUP
- Available in small packaging

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Organic vs. Synthetic

- Derived from an organic source
- Biodegrades rapidly
- Varying levels of toxicity

3 Classes

- Botanicals
  - Pyrethrum
  - Neem™
- Microbials
  - Bt sprays
- Naturalytes
  - Spinosad™

Neem Oil

- Manufactured via chemical reactions
- May persist in environment

Synthetic Pyrethroid

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Organic ≠ Saf

Rotenone

- Organic pesticides may be just as toxic, or more toxic than, synthetics.
- Rotenone may only be used to kill fish
- Derived from Lonchocarpus heptaphyllus

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Pesticide Hazards

Some pesticides are very toxic.

What is the *risk* involved in using them?

Risk = toxicity x exposure

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Pesticide Hazards

Zero exposure = zero risk

High toxicity x good management
= Low risk

Low toxicity x poor management
= High risk hazard

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How is toxicity determined?

- Acute toxicity is usually determined by animal testing.
- LD_{50} stands for "lethal dose fifty."
  - This is the dose that killed half of the animals in a dose-response study.
  - The smaller this number, the more poisonous the pesticide.

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Examples of LD_{50}

Number is LD50 in mg of substance per kg of body weight for mice or rats

- table salt 3750 mg/kg
- aspirin 1750 mg/kg
- diazinon 1250 mg/kg
- imidacloprid 450 mg/kg
- carbaryl 250 to 850 mg/kg
- caffeine 150 to 200 mg/kg
- nicotine 55 mg/kg

The smaller this number, the more poisonous the substance.

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How Much is that for a 175 lb. person

- table salt 3750 mg/kg = 1.5 to 2 cups
- aspirin 1750 mg/kg = 350 aspirin
- Diazinon 1250 mg/kg
- caffeine 200 mg/kg = 160 cups
- Rotenone 130 mg/kg
- nicotine 55 mg/kg = 25-55 cigarettes



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Routes of Entry

- There are 4 main routes:
  - **Dermal**
  - **Ocular**
  - **Inhalation**
  - **Oral**
- Dermal & inhalation are the most common routes of pesticide exposure.

- If exposed, contact the Poison Control Center at **1-800-222-1222**

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Pesticide Hazards

Toxicity can be:

Acute – damage resulting from a single exposure

Chronic - damage resulting from long-term (repeated) exposure

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Signal Words

	Caution (Cat. IV)	Caution (Cat. III)	Warning (Cat. II)	Danger (Cat. I)
Oral LD_{50} in mg/kg	> 5000	500-5000 harmful	50-500 may be fatal	< 50 **fatal**
Inhalation LD_{50} in mg/l	> 20	2-20 harmful	0.2-2 may be fatal	< 0.2 **fatal**
Dermal LD_{50} in mg/kg	> 5000 Mild Irritation	2000-5000 Moderate Irritation	200-2000, Severe Irritation may be fatal	< 200 **Corrosive, irreversible, fatal**
Eye Effects	No Irritation	Reverses in 7 days	More than 7 Days	**Corrosive, irreversible**

57

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Risk

- **Risk = toxicity x exposure**
  - Low toxicity x poor management = **High risk**
  - High toxicity x good management = **Low risk**
  - Zero exposure = **zero risk**

The toxicity of a pesticide can't be changed, but risk can be managed by the person applying it

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Prevent Pesticide Poisoning

- Never store pesticides in food containers
- Keep in original container unless actively spraying
- Keep pesticide labeled with product name and EPA registration number
- Store pesticides in locked cabinets that are inaccessible to pets and children
- Post emergency phone numbers in a prominent place
- If pesticide exposure or ingestion occurs, call 1-800-222-1222 or 911 immediately

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How should you store pesticides?

- Locked area
- Ventilated
- In their original labelling
- Stable temperatures (40-90 F°)
- Never store in application equipment
- Off the ground, but close to ground level if possible

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Common Symptoms of Pesticide Poisoning

Mild or early symptoms:
Headache
Fatigue, Weakness
Dizziness
Restlessness
Nervousness
Perspiration
Nausea
Diarrhea
Loss of appetite
Loss of weight
Thirst
Moodiness
Joint soreness
Irritation of skin, eyes, nose, throat

Moderate symptoms:
Nausea
Diarrhea
Excessive saliva
Stomach cramps
Excessive perspiration
Trembling
No muscle coordination
Muscle twitches
Extreme weakness
Mental confusion
Blurred vision
Difficulty in breathing
Cough
Rapid pulse
Flushed or yellow skin
Weeping

Severe symptoms:
Fever
Intense thirst
Increased rate of breathing
Vomiting
Uncontrollable muscle twitches
Pinpoint pupils
Convulsions
Inability to breathe
Unconsciousness

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If Pesticide Poisoning Occurs

- Read labels carefully prior to use so that you know what to expect and how symptoms may be treated
  - Statement of practical treatment
- If you get pesticide in eyes or on skin, immediately flush with water
- Call 911 for immediate medical attention
  - Statement of practical treatment
  - EPA Registration number
- If you notice any unusual symptoms, call National Poison Control Center: **800-222-1222** for trained medical attention
  - Keep label accessible
    - EPA registration number and product name

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The Pesticide Label

Contains information essential for effective, safe, and legal use of product.

"The label is the law."

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A legal document which describes:

- Ingredient(s) of the product.
- Indicates level of toxicity.
- Approved uses of the product.
- Application rates
- Environmental hazards of its use

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The elements of a pesticide label:

- Brand name
- Common name
- Chemical name
- Ingredient statement
- Type of formulation
- Net contents
- Name & address of manufacturer
- Environmental hazards
- Physical & chemical hazards
- Signal words & symbols
- Statement of practical treatment
- Directions for use
- Pre-harvest interval

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Brand, Common and Chemical Names

- Different manufacturers may market the same active ingredient under different brand names.
- Do not choose products by brand name alone. Read the active ingredients on the label.

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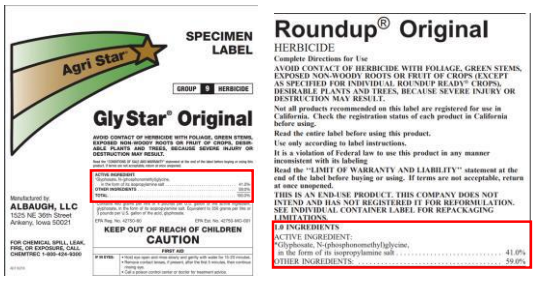

SPECIMEN LABEL

Agri Star

GROUP 9 HERBICIDE

GlyStar® Original

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS (EXCEPT AS SPECIFIED FOR INDIVIDUAL ROUNDUP READY® CROPS), DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

ACTIVE INGREDIENT
Glyphosate, N-(phosphonomethyl)glycine,
in the form of its isopropylamine salt 41.0%
OTHER INGREDIENTS 59.0%
TOTAL: 100.0%

Manufactured by:
ALBAUGH, LLC
1525 NE 36th Street
Ankeny, Iowa 50021

FOR CHEMICAL SPILL, LEAK, FIRE, OR EXPOSURE, CALL CHEMTREC 1-800-424-9300

KEEP OUT OF REACH OF CHILDREN
CAUTION
FIRST AID

Roundup® Original

HERBICIDE

Complete Directions for Use

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS (EXCEPT AS SPECIFIED FOR INDIVIDUAL ROUNDUP READY® CROPS), DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

Not all products recommended on this label are registered for use in California. Check the registration status of each product in California before using.

Read the entire label before using this product.

Use only according to label instructions.

It is a violation of Federal law to use this product in any manner inconsistent with its labeling

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. THIS COMPANY DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

1.0 INGREDIENTS

ACTIVE INGREDIENT:
*Glyphosate, N-(phosphonomethyl)glycine,
in the form of its isopropylamine salt 41.0%
OTHER INGREDIENTS: 59.0%

71

- P
- A ai's

72

73

74

Common Label Violations

If one glug is good, two is better.

- If the label says it works great in the driveway it should be dynamite in the garden
- If it says to use it every 2 weeks, it should work even better every week
- There's just a bit left over, I'll pour it down the drain.
- Gloves are for wimps

75

What *is* allowed

- apply at a dose, concentration or frequency less than that listed on the label, but never more!
- apply a pesticide for a pest not listed on the label if the plant or other target is listed.
- use any appropriate equipment not specifically prohibited by the label.
- mix with pesticide(s) &/or fertilizer(s) not specifically prohibited.

76

The pesticide label

When should you read the pesticide label?

- Before **purchasing** the product.
- Before **using** the product.
- Before **storing** the product.
- Before **disposing** of the product or empty container.

77

Personal Protective Equipment

- Apparel and devices worn to protect the body from contact with pesticides.
- Most of a pesticide spilled on the skin is absorbed in the first few minutes
- You are legally required to follow all PPE instructions on the label.
- Some label listings are activity-specific, such as for mixing & loading.

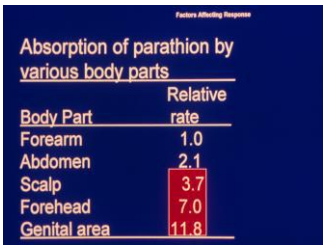
78

Personal Protective Equipment (PPE)

- pants
- long-sleeves
- gloves
- shoes or boots
- goggles
- face mask
- hat
- protective outerwear

79

Pesticide Sensitivity



80

Body Protection

- Always wear a long-sleeved shirt & long-legged pants & recommended PPE.
- An apron may be required during mixing.

81

Head & Neck

- A chemical-resistant hood or wide-brimmed hat will help keep pesticides off your head, neck, eyes, mouth & face.
- Plastic "safari" hats with plastic headbands work well and are relatively cool.

82

Personal Protective Equipment (PPE)

Several types of coats made of different fabrics, with and without hoods

83

Respiratory Tract

- If the label directs you to wear a respirator, you must, and it must be NIOSH/MSHA approved
- NIOSH/MSHA approval number prefixes:
  - TC-21C for dust/mist masks
  - TC-23C for vapor cartridges
  - TC-14G for vapor canisters

84

Eyes

- PPE for eyes include goggles, face shields and safety glasses with shields over brow & on sides.
- Goggles or glasses work well with half-face respirators.

85

86

Hands & Feet

- Wear waterproof gloves any time you may get pesticides on your hands.
- Chemical-resistant hand and footwear may be required.
- Keep at least one extra pair of gloves and footwear available in case of contamination.
- If you must remove your gloves during a handling activity, wash your gloves before removing them.

87

Gloves and Liners OK

88

Use Water Resistant Boots

89

Shoe or boot coverings

90

Choosing PPE

- Read the label.
- Label will commonly require a "long-sleeved shirt and long pants" (not defined as PPE).
- PPE include:
  - Coveralls
  - Chemical-resistant suits, gloves, footwear
  - Protective eyewear
  - Respirators

91

Application Equipment

- There are several types of application equipment.
- You should choose equipment that allows you to make safe and effective pesticide applications.




92

Application Equipment - Sprayers

93

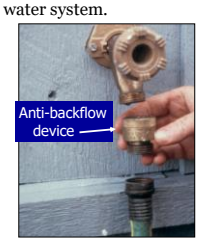
Hose-end Sprayers

- Hose-end sprayers are proportioned that mix a concentrated pesticide with water and emit a spray of diluted pesticide.
- These may be very useful when making applications to the ground with high volumes of water.
- This type of sprayer may be the only non-mechanical way of spraying trees and large shrubs.

94

When using a hose-end sprayer:

Place anti-siphon device between sprayer and water source to prevent back siphoning of pesticides into your water system.

95

Compression Sprayers

Pressurized with a hand-operated pump.

Require agitation and uniform tank pressure for effective spray application.

With tank capacities of more than ~ 1.5 gallons, you should consider a backpack sprayer.

May not be suitable for spraying large shrubs and trees.

96

Backpack Sprayers

- Larger capacity
- Tend to be more comfortable
- Operate off of hand pressure or battery-powered pressure
- More mobile than some other options
- Nozzles can be replaced/switched out

97

Mixing & Loading

- Requires extra precautions
  - breezes
  - pesticide is in concentrated form
  - don't leave tank unattended
  - eating, drinking, smoking
- Follow the label directions each time you mix pesticides. Labels change!

98

Calibration & Calculating Amounts

99

Calibration & Calculating Amounts

To apply the correct amount of pesticide, you need to know:

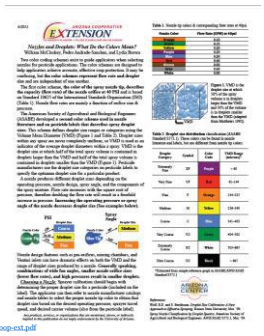
How much of the pesticide to apply per unit of area.
How large the area is.
How much liquid your sprayer puts out per unit of area.

The output volume depends on:

pressure
nozzle size
nozzle height
walking speed

calibration

100



https://www.mssoy.org/uploads/files/arizona-coop-ext.pdf

101

Calibrate sprayer for Small spaces- 1000 ft² Method

- Measure out 1000 ft² (20x50 feet)
- Using WATER ONLY, fill your backpack sprayer halfway
- Time yourself spraying the marked off area
- Once finished, fill the sprayer back up to halfway
- Spray water into a measuring cup for the same period of time it took to spray
- Record the Oz. Sprayed, and repeat 3 times
- Average the three: Oz./1000 ft² determined

102

Example: determine how much to spray

- Sprayer output: 57 Oz/1000 ft²
- Label rate: 2 Oz Chemical/ 1000 ft²
- Area to treat: 2600 ft²

103

Example: determine how much to spray

1. To determine the total spray mixture needed, set up the following ratio and cross multiply:

$$\frac{57 \text{ oz.}}{1{,}000 \text{ sq. ft.}} = \frac{X \text{ oz.}}{2{,}600 \text{ sq. ft.}}$$

X = 148.2 oz. (round off to 148).

2. To determine the amount of herbicide needed, set up the following ratio and cross multiply:

$$\frac{2 \text{ oz.}}{1{,}000 \text{ sq. ft.}} = \frac{X \text{ oz.}}{2{,}600 \text{ sq. ft.}}$$

X= 5.2 oz. of herbicide

3. To treat the target area, a little more than 5 oz. of herbicide should be added to 143 oz. of water (148 – 5). Because there are 128 ounces in 1 gallon, this will mean adding 5 ounces of herbicide to 1.1 gal. of water (143/128 = 1.1 gallons of water).

104

Calculating how much pesticide goes into a tank

- MG's DO NOT calculate application rates for clients.
- There are several great publications for this

- https://pesticidestewardship.org/calibration/backpack-sprayer/
- https://www.aces.edu/wp-content/uploads/2020/11/ANR-2681-128CalibrationMethod_102720L-A.pdf
- https://www.mssoy.org/uploads/files/arizona-coop-ext.pdf

105

Re-entry Interval

- The period of time that must pass between treatment and reentry
- Check the label for REI (often 12, 24 or 48 hours, though many say, "until dry").

Preharvest Interval

number of days allowed between the last pesticide application and the day of harvest.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 4 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is: coveralls, shoes plus socks and chemical-resistant gloves made of any waterproof material.

106

Applying Pesticides

Cleanup & Disposal

107

Washing PPE

- Wash pesticide-contaminated items separately from uncontaminated clothing & laundry.
- Avoid direct contact with contaminated items, and work in a well-ventilated area.
- If in doubt about ability to clean an item, discard it!

108

Eyewear/Respirators

- Wash goggles, face shields, safety glasses & respirator bodies, and face pieces with detergent & and hot water after each day of use.
- Sanitize by soaking them for at least 2 minutes in a mixture of 2 tablespoons bleach in a gallon of water. Rinse thoroughly!

109

Storage

Original container only
Out of reach of children & pets
Avoid temperature extremes
Avoid contamination of wells & surface water
Leak proof containers

110

Plastic Closeable Containers are easier to see through

111

Disposal of Pesticide Containers

Empty Containers: (not banned)

- Cardboard containers in trash (not burned)
- Triple rinse glass/plastic, apply rinse water
- Dispose of empty container in trash, or
- recycle/return to dealer if possible

Leftover pesticide or banned products:

- Check DEQ Home Hazardous Waste
- collection schedule-do not dispose

http://www.deq.state.or.us/wmc/solwaste/hhw.html
1-800-452-4011

112

Cleaning Pesticide Spills

Keep the area well ventilated

- Wear gloves and protective clothing
- Contain the spill with absorbent material
- (cat litter, clay or sand)
- Scoop material into sealed container
- Wash the surface with soap and water
- Dispose of materials as HHW

113

Softer Pesticides and IPM

- Integrate various pest management systems to reduce pesticide use
- New products that are less residual and softer on predators
- Rotate chemistries

114

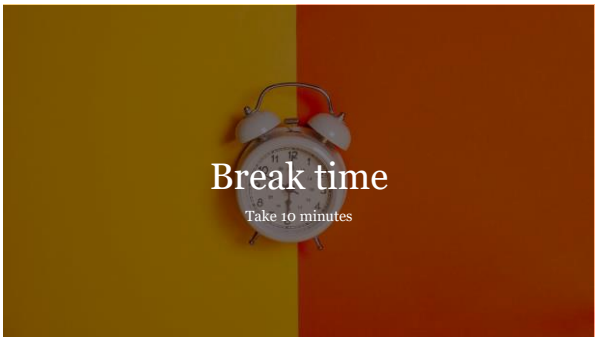
Pesticide Recommendations for Homeowners

Plant Disease Control:
PNW Disease Management Handbook
http://plant-disease.orst

Insect Pest Control:
PNW Insect Management Handbook
http://insects.ippc.orst.edu/pnw

Weed Control:
PNW Weed Handbook
http://weeds.ippc.orst.edu/

115



116

Fertilizers and Soil Amendments

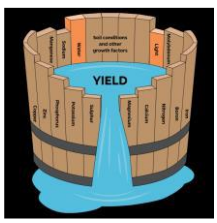
117

Why do we care about soil fertility?

118

Nutrient deficiencies can limit yield

Liebig's Law
Yield is proportional to the amount of the most limiting nutrient, whichever nutrient it may be.



119

Do you need to fertilize your garden?

- Which nutrients (elements) do you need?
- What type of fertilizer material should you use?
- How much should you apply?
- How should you apply?
- When should you apply it?
- Will you get a return on your investment?

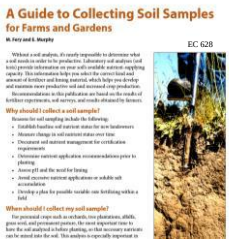
120

Test your soil!

Soil testing provides an estimate of the quantity of nutrients which should become 'available' during the growing season.

Not the total amount of nutrients in the soil.

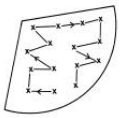
121


A Guide to Collecting Soil Samples for Farms and Gardens

EC 628

122

Soil sampling gives you information about the chemical composition of your soil



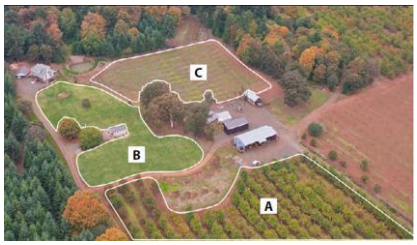
Collect 15 – 20 subsamples randomly around the management unit.
Combine into one composite sample to submit to certified lab.

123

Management Units

Use field characteristics (soil type, size, history)

WEBSOILSURVEY.*NRCS.USDA.GOV*

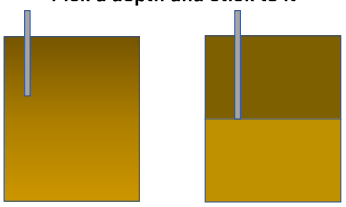


124

If sampling a small area (one tree) combine at least four cores

125

Sampling depth is very important
Pick a depth and stick to it



Uncultivated

4 – 6 inches

Cultivated

6-8 inches
"plow layer"

126

How often should I take a soil sample?

- Prior to a new landscape or garden
- New property
- Every 2 – 5 years in home gardens/lawns/landscapes, use the same lab or testing methods
- Frequently enough to make good decisions on fertilization
- Having a problem

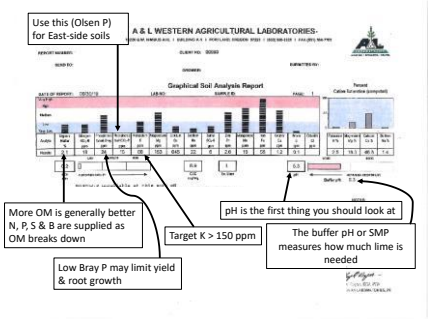
Time of year generally does not matter for routine chemical analysis but be consistent.

127

What do you do with your soil samples?

- Send them to a lab for chemical analysis
- Soil test methodologies are calibrated

128



129

Plants need nutrients to grow

Macronutrients
- Primary - Nitrogen (N), Phosphorus (P), Potassium (K)
- Secondary – Calcium (Ca), Magnesium (Mg), Sulfur (S)

Micronutrients
- Zinc (Zn), Iron (Fe), Copper (Cu), Manganese (Mn), Boron (B), Molybdenum (Mo), Chlorine (Cl)

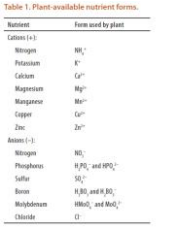


Table from OSU Publication EC 1478, Soil Test Interpretation Guide

130

NPK- What do they do?

N (ammonium – NH_4^+ or nitrate – NO_3^-)
- important for healthy plant growth, protein formation, root growth, chlorophyll, carbohydrate use.

P (phosphate – HPO_4^{2-})
- essential for vigorous growth of seedlings, especially in cool, wet, spring weather. Key role in photosynthesis, energy storage and transfer, and cell division. Vital to flowering, seed formation, and maturation.

K (Potassium – K^+)
- important for disease resistance and starch formation. Helps plants adapt to environmental stress. Essential for photosynthesis, protein synthesis, starch formation, and translocation of sugars.

131

Nutrient deficiencies can cause visual symptoms

132

- Yellowing of older leaf material – N is mobile in plants
- Stunted growth, reduced plant vigor
- General chlorosis of entire plant

NITROGEN (N) Deficiency

133

Table 1. Nitrogen requirement for vegetable crops (lb/1000 ft) Based on seasonal nitrogen uptake (adapted from Gaskell et al. 2007). From PNW 646, pg. 4

Low: 3 lb/1000ft2	Med: 4lb/1000ft2	High: 5 lb/1000ft2
Baby greens	Carrot	Broccoli
Bean	Corn, sweet	Cabbage
Cucumber	Garlic	Cauliflower
Radish	Lettuce	Celery
Spinach	Melon	Potato
Squash	Onion	
	Pepper	
	Tomato	

Multiply values by 44 to approximate the conversion of lb/1000 ft to lb/acre.

134

Table 2. Phosphorus (P) soil test categories and suggested fertilizer rate recommendations.

	West of Cascades Bray P1 test P (ppm)	East of Cascades Olsen test P (ppm)	Recommendation (lb P_2O_5/acre)
Low	<20	<10	0–300
Medium	20–40	10–25	0–200
High	40–100	25–50	0–30
Excessive	>100	>50	0

Table from OSU Publication EC 1478, Soil Test Interpretation Guide

- Purpling of leaves, especially in leaf veins. Mobile in plants so symptoms show in older leaves first.
- May result because of cold soil temperatures
- Sparse flowering, poor fruit and seed development
- **PHOSPHORUS (P) Deficiency**

135

Photos: http://landresources.montana.edu/soilfertility/kdeficiency.html

Table 3. Extractable potassium (K) soil test categories and suggested fertilizer rate recommendations.

	Extractable or soil test K	Recommendation (lb K_2O/acre)
Low	<150 ppm*	100–300
	<0.4 meq/100 g soil	
Medium	150–250 ppm	60–250
	0.4–0.6 meq/100 g soil	
High	250–800 ppm	0
	0.6–2.0 meq/100 g soil	
Excessive	>800 ppm	0†
	>2.0 meq/100 g soil	

* For ammonium acetate or sodium bicarbonate extraction method.
† When extractable K is excessive, determine soil and irrigation water electrical conductivity.

Table from OSU Publication EC 1478, Soil Test Interpretation Guide

- Leaf margins turn chlorotic and then necrotic.
- Tip and marginal burn starting on mature leaves
- Lower leaves turn yellow
- Weak stalks and plants lodge easily
- Mobile in plant so symptoms appear on older leaves first

- **Potassium (K) deficiency**

136

- Light green color or uneven chlorosis of young leaves, tip burn on mature or new leaves, distorted new growth.
- Blossom-end rot on tomatoes, peppers and eggplants?

- **Ca Deficiency caused by uptake issue**

Calcium uptake is inhibited by watering- too much or too little!

Ohio State University Extension

137

http://www.omafra.gov.on.ca/IPM/images/grapes/plant-nutrition/magnesium/magnesium7_zoom.jpg?rand=481915241

Table 4. Extractable magnesium (Mg) soil test categories and suggested fertilizer rate recommendations.

	Extractable or soil test Mg	Recommendation (lb Mg/acre)
Low	<60 ppm	10–100
	<0.5 meq/100 g soil	
Medium	60–300 ppm	0–60
	0.5–2.5 meq/100 g soil	
High	>300 ppm	0
	>2.5 meq/100 g soil	

Table from OSU Publication EC 1478, Soil Test Interpretation Guide

- Interveinal chlorosis on older leaves, proceeds to younger leaves with more severity
- Curling of leaves upward along margins
- **Magnesium (Mg) deficiency**

138

Soil Test Report: Other items

- Nitrogen (N) and Sulfur (S)
  - Very mobile in soil so regular soil tests not reliable
  - Tissue analysis for S and N better than soil test for S and N

139

Boron (B)

- Not routinely provided in soil tests
- Check with lab, you may have to request it
- Crops susceptible to B deficiency: cabbage, broccoli, cauliflower, cane berries, strawberries, beets, carrots)
- Many soils in western OR are deficient
- If test results indicate less than 1ppm, add Boron. See pg. 4 of Fertilizing your garden for recommendation
- Be careful – don't over apply, too much can be toxic to plants!

Photo: WSU, http://sarvision.wsu.edu/wp-content/uploads/2016/02/broccoli-boron-deficiency-sl.jpg

140

Basic Fertilizing Principles

- Nitrogen, Phosphorus, Potassium most limiting nutrients
- pH often most limiting factor

142

Fertilizer and Soil Amendments

A natural or synthetic material that provides useful quantities of nutrients in forms soluble in soil

- Most soluble nutrients become immobilized in soil (adsorbed, incorporated into humus):
- This is GOOD. It increases soil reserves
- Increased soil reserves → increased concentration in soil → greater availability to plants

143

Types of fertilizers

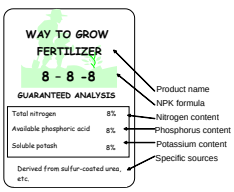
Synthetic fertilizers (urea, diammonium phosphate, potassium chloride, etc.)

Organic fertilizers (bone meal, compost, crab or fish meal, manure, etc.)

144

Fertilizer Mixes

- Listed as N - P - K
- Numbers are %
- Example:
  - Fifty pound bag of contains how much nitrogen, phosphorus and potassium?

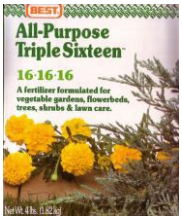


145

Comparing organic and synthetic fertilizers

	Organic Fertilizers	Synthetic Fertilizers
Source	Natural materials; little to no processing	Manufactured or extracted from natural materials; often undergo extensive processing
Examples	Manure, cottonseed meal, rock phosphate, fish by-products, ground limestone	Ammonium sulfate, processed urea, potassium chloride
Nutrient Availability	Usually slow-release; nutrients are released by biological and chemical processes in soil	Nutrients usually are immediately available to plants
Nutrient Content	Usually low	Usually high

146



147

Commercial Organic Fertilizers

148

Fertilizing with manures

- Watch out for weeds and pathogens
- Consider application method and timing
- Rule of thumb: 5 gallon bucket of cow manure per 50 square feet.
- Why would composted manure a better source?

149

Nutrient value of manures

Animal	N lbs/ton	P_2O_5 lbs/ton	K_2O lbs/ton
Beef	11.3	8.4	9.5
Chicken	27.3	23.5	13.2
Goat	22.0	5.4	15.1
Horse	12.1	4.6	9.0
Sheep	22.5	7.6	19.5

150

Using manure

- Nutrient content can be variable
- Should be tested for best results
- Often over supplies P & K to get amount of N needed for crop needs
- Do not over apply
- Nitrogen availability not guaranteed

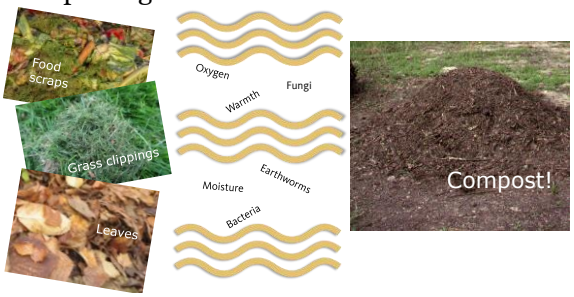
151

Elements of Compost

Soil, Compost and Fertilizer Part 7

152

Composting



153

Compost Promotes Soil Health

Compost provides many benefits to soil, including:

- Increases soil organic matter
- Supports earthworms and beneficial soil microbes
- Increases soil water holding capacity
- Increases soil nutrient retention
- Can improve drainage
- Helps roots spread freely

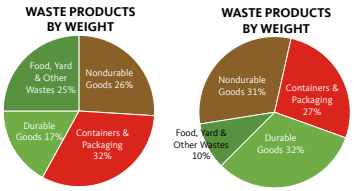
Soil is easier to work and better for plant growth

154

Compost Reduces Waste

- The average U.S. household generates over 650 lbs of compostable materials each year.
- Limited landfill space should be reserved for materials that cannot be recycled or composted

Roseburg, OR Landfill
August, 2004



155

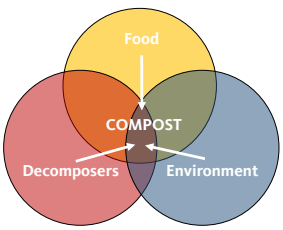
Other Benefits of Compost

- Can reduce the need for fertilization
- Increases growth of some woody plants
- Can suppress plant disease

156

Ingredients of Good Compost

- Decomposers
  - Microbes, earthworms and arthropods that do the work
- Food for decomposers
  - Organic materials – Carbon & Nitrogen
- Suitable environmental conditions
  - Oxygen
  - Moisture – 40-60%
  - Warmth – 90-140 deg. F.



157

Where to Find Decomposers?

If you build it, they will come... (video)

158

Commercial Starters

- Can be beneficial
- Not usually needed
- Add some finished compost

159

Browns and Greens

- Carbon-rich organic wastes are known as "**BROWNS**"
  - Carbon to Nitrogen Ratio >30:1
  - Bulk materials
- Nitrogen-rich organic wastes are known as "**GREENS**"
  - Carbon to Nitrogen Ratio <25:1
  - Energy materials
- Ideal C:N ratio for compost piles ≈ 30:1
  - 1 part green, 2 parts brown

160

Browns Relatively high carbon content (>30C:1N)

- Leaves (30-80:1)
- Straw (40-100:1)
- Manure (horse) with bedding (60:1)
- Sawdust (100-500:1)
- Wood chips (600:1)
- Paper (150-200:1)
- Shredded Newspaper: 170:1

161

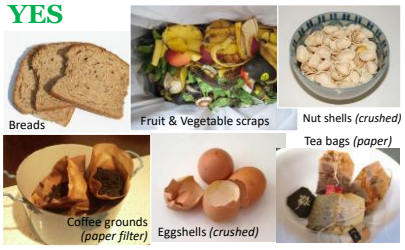
Greens Relatively high nitrogen content (<25C:1N)

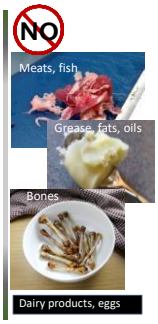
- Fruit & Vegetable scraps (15-20:1)
- Coffee grounds (20:1)
- Grass, green plant clippings (15-25:1)
- Fresh Manure
  - Cow (20:1)
  - Horse (25:1)
  - Poultry (10:1)
  - Sheep (17:1)

162

What to Compost: Food Scraps

YES





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What to Compost: Garden and Yard Waste

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What to Compost: Manures

165

What to Compost: Wood Products

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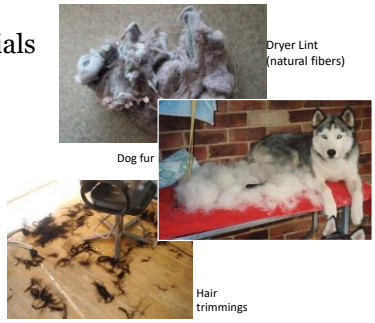
Other Materials

- Natural fabrics (cotton, linen, wool) shredded
- Dryer lint (cotton, linen, wool)
- Fur and hair
- Soil amendments: Rock powder, greensand, bone meal etc



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Compost with Care

Diseased plants
Pest-infested plants
- Safest if hot composted at >140 degrees F (60 C)

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Compost with Care

169

Herbicide Residues in Compost

- Avoid materials sprayed with Clopyralid (and similar herbicides)
  - Sold under the names: Redeem, Stinger, Transline, Confront, Lontrel, Curtail, and Millennium Ultra
  - Straw
  - Manure from animals fed sprayed hay
- Use compost as soil amendment
  - Planting medium or mulch more risky if contaminated

Clopyralid damage damage on potatoes

170

Building A Compost Pile

Soil, Compost and Fertilizer Part 8

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Building a HOT Compost Pile

- Collect materials for a minimum size of 1 cubic yard = 3x3 ft
- 2 parts browns to 1 part greens, + desired amendments
- Chop coarse materials
- Mix and moisten materials as pile is assembled. Cover.
- Should heat to 120-150deg
- Turn when temp drops and volume down by 1/2
- Finished when it cools, about 8 weeks

Should be free of viable seeds, rhizomes and disease organisms

172

Building a COLD Compost Pile

Compost Happens!

- 2 parts browns to 1 part greens
- Add materials as acquired
- Dig new materials into center
- Keep moist
- Harvest when center appears done
- Re-compost unfinished parts
- *Seeds, rhizomes and disease organisms may still be viable*

173

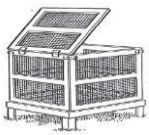
Types of Compost Systems

- Container is not essential
- Min. size 1 cubic yard – 3x3 ft
- Hot or Cold composting

174

Open Compost Containers

- Min. size 1 cubic yard – 3x3 ft
- Walls determine size
- Can hold in moisture



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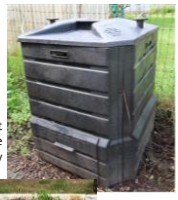
Closed Compost Containers

- Fixed
- Rotating



Simple plastic compost bin from local waste collection company

Double rotating bins allow for compost in 2 stages

Convenient location in vegetable garden

176

Three-Chambered Bin

Three batches of compost in varying stages of decomposition

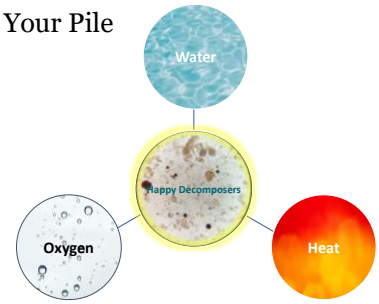
- Bin #1 for 3-6 weeks
- Turn into bin #2 for 4-8 weeks
- Turn into bin #3 to cure
- Meanwhile start another pile in bin #1
- Sift finished compost if desired

System with built-in sifter

Removable slats in the front for easy access

177

Caring for Your Pile



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Turning Your Compost

Aeration = Oxygen

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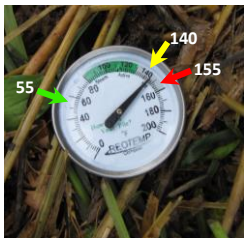
Temperature

- Active composting occurs between 55°F to 155°F
- < 55°F = too cold for most microbes
- >140°F = too hot for most microbes, but good for curing
- 120-150°F for 15+ days = most pathogens killed
- A soil or compost thermometer is useful



180

Water

40% to 60% moisture is best

- As wet as a squeezed-out sponge
- If too dry, bacterial activity will slow or cease
  - Add water as you turn the pile
- If too wet anaerobic conditions occur
  - Add browns and/or turn the pile

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When is Compost Finished?

- No longer heats up when turned
- Dark brown color
- Crumbly and loose
- Smells earthy
- Original materials are mostly not recognizable
  - Sift out twigs, woody material
- Pile has shrunk to about 1/3 original volume

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Be Patient – Let Compost Cure

Uncured compost
- Can burn plants through phytotoxicity
- Can foster root rot and damping off in young seedlings
- Can rob the soil of nitrogen
- Could still have herbicide residues if those were present

Allow to cure at least 4 weeks

Nasturtiums and tomatoes growing in unfinished compost

183

Tests for Finished Compost

Important for compost used in potting mix or for seedlings

Bag test: sealing compost in a plastic bag for several days should produce no foul odor

Germination test: compare seed germination in compost vs. standard potting mix

Finished compost Potting mix

184

Harvesting Compost

- Sift if desired
- Recognizable plant material? Outer parts of pile may not be finished.
- Turn unfinished material into center of new pile

Uncomposted material around outside edge of pile

185

Using Finished Compost

- Soil amendment
  - Work well into soil. Add to planting holes.
- Mulch (if seed-free)
  - Won't deter weeds.
- Lawn topdressing (if seed-free)
  - Core lawn, rake in fine compost. Seed-free only.
- Potting mix
  - <1/3 by volume. Fine, well-cured compost.
- Don't over-apply

Weed and other seeds sprouting in a sample of cold compost

186

Commercial Compost

- Inspect for trash
- Earthy smell
- Questions to ask vendor:
  - Ingredients?
  - Temperature
  - Tested for contaminants, herbicide residues?
  - Length of time composted
- Evaluate effect on seedlings before using

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Compost Troubleshooting

Problem	Cause	Remedy
Foul smell	Meats	Remove meat
Foul smell	Anaerobic (low oxygen) conditions. Excess moisture, compaction	It needs more air and less water. Turn pile, add browns
Ammonia odor	Too much N or pH too high	Add high carbon material (browns), turn pile
Pile is too dry		Add more moisture
Pile is too wet	Needs more air and less water	Turn pile, add browns. Cover in rainy weather.
Pile won't heat up	It is too small, or weather is too cold	Build a larger pile and cover it.

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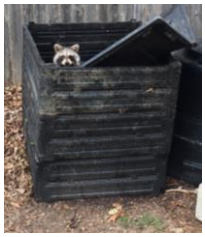
Animals and Compost Piles

- Rodents and raccoons
  - Remove meaty, fatty foods
  - Turn pile to raise temperature
  - Use rodent-proof bin
- Flies and gnats
  - Don't leave kitchen waste exposed.
  - Mix or cover with brown materials, finished compost, or soil
- Snakes
  - Not pests – garden helpers
  - Say thanks and move on!
- Dogs
  - Cover the pile



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Manure vs. Compost

- Compost is the active management of manure and bedding
- Composts are lower in plant-available N
- Composting kills weeds seeds & pathogens
- More uniform material, can be easier to handle

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Herbicides in manure and compost

- Clopyralid and aminopyralid herbicides can persist in manure and compost
- Active at very low concentrations
- Do not use manure or compost from animals fed forages treated with these herbicides in vegetable or home gardens (kills broadleaf plants)

191

Food safety considerations with fertilizers

- Raw manure
- Composted manure*
- Compost made with n manure
- Commercial organic c chemical fertilizers

High risk

Low risk

* Compost needs to be properly heat-treated.

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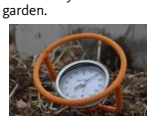
How to minimize risk from fertilizers

- Do not use non-composted manure in your edible garden.



- If you do use manure:
  - Incorporate it into the top 8" of soil.
  - Apply at least 90 or 120 days before harvest.
  - Be aware of potential from cross contamination
  - Be very careful when using manure or compost teas for foliar feeding.

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Other Soil Amendments

- Leaves, plant materials, food wastes and other composted materials
- Sawdust, wood shavings
- What about using stall waste from a horse farm on your garden?

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What About Wood Ashes?

- Readily available K, Ca, and Mg
- Increase soil pH
- Salt injury could be a problem if too much is applied
- Avoid direct contact with plant roots

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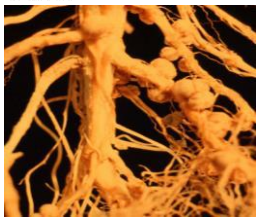
Benefits of Cover Crops to Soil Fertility

- Nutrient cycling
- Nitrogen additions by Rhizobium associated with legumes
- Enhanced phosphorus availability
- pH buffering
- Energy and food source for soil biota

Rhizobium bacteria nodules



http://www.nrcs.usda.gov/Internet/FSE_MEDIA/nrcs142p2_050219.jpg

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Applying fertilizers

- Nitrogen in chemical fertilizers is highly soluble, do not need to mix into soil but do need to irrigate.
- Organic sources of N should be mixed into top 2-3 inches
- Phosphorous moves slowly in the soil. Mix in or band below seeds.
- Potassium fertilizers should be worked into the soil. Do not allow K fertilizers to contact plant roots.

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Nutrient mobility & placement

- Broadcast (incorporate or topdress)
- Band
- Side dress

Nutrient	Mobility in soil
Nitrogen	Mobile as nitrate; Immobile as ammonium
Phosphorous	Immobile
Potassium	Somewhat mobile
Calcium	Somewhat mobile
Magnesium	Immobile
Sulfur	Mobile

See page 3 of "Fertilizing your Garden"

200

Best Practices: 4Rs of Nutrient Management

201

Best Management of Nutrients

- Apply fertilizer in small doses
- Keep fertilizer application rates in balance with crop utilization rates
- Use soil tests to evaluate trends
- Protect water sources
- Prevent erosion & runoff
- Use conservation tillage

202

Take home message

- Soil is alive and complex
- Soil is more than "dirt"
- Add organic matter!
- Keep the soil covered
- Apply lime and fertilizer based on soil test results
- Correct pH is essential for nutrient availability

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Other helpful links

- www.cdms.net
- www.greenbook.net
- Agrian label lookup: https://www.agrian.com/labelcenter/results.cfm
- uspest.org can run over 100 insect pest and disease models and access weather data from across Oregon and the US

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Online resources

uspest.org can run over 100 insect pest and disease models and access weather data from across Oregon and the US

Pest Management Guide for Tree Fruits
Hood River • The Dalles • White Salmon • Rogue Valley
https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em8203.pdf

PNW Insect Management Handbook
https://pnwhandbooks.org/insect/tree-fruit/pear

UCIPM—Pest Management Guidelines for Pears
http://ipm.ucanr.edu/PMG/selectnewpest.pears.html

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Tell me how I did!
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Oregon State University Extension Service

Thank you

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