Herbicide 101

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What are Herbicides?

- Compounds that disrupt plant function and usually lead to death of the plant
- Mechanism of action
 - Many inhibit enzymes essential to plant function
 - Some disrupt plant auxins that regulate growth
 - Others inhibit photosynthesis
 - Still others destroy plant membranes

Chemical Weed Control as a Tool

 Understanding the properties of a tool makes it easier to use it correctly and safely



Herbicide Products, A Combination of:

- Active ingredient(s) What does the job
- Co-formulants (often referred to as "other ingredients"):
 - Components that make the AI "sprayable" and stable
 - Adjuvants Make the AI work better
 - Dyes
 - Others
- Major types of formulations: salts, esters, emulsions, dry
- While many products can have the same AI, they can have different "recipes"

Imitator[®] Plus Herbicide

Avoid herbicide contact with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees because severe injury or destruction may result.

ACTIVE INGREDIENT:

Glyphosate in the form of its

isopropylamine salt*	41.0%
OTHER INGREDIENTS:	59.0%
TOTAL	100.0%

Contains 480 grams per liter or 4 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 356 grams per liter or 3 pounds per U.S. gallon of the acid, glyphosate.

KEEP OUT OF REACH OF CHILDREN CAUTION See FIRST AID Below

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

CAUTION: Harmful if absorbed through skin, if inhaled, or if swallowed. Causes moderate eye irritation. Avoid breathing of spray mist. Avoid contact with skin, eyes, and clothing.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear: Long-sleeved shirt and long pants, shoes plus socks, and chemical-resistant gloves (such as natural rubber, Selection Category A).

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

ENGINEERING CONTROLS

When handlers use closed systems, enclosed cabs or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

USER SAFETY RECOMMENDATIONS





HERBICIDE

Rodeo®

HERBICIDE

[®] ™ Trademarks of Dow AgroSciences, DuPont or Pioneer and their affiliated companies or respective owners

For control of annual and perennial weeds and woody plants in natural and production (plantations), forests for site preparation, mid-rotation release treatments, timber stand improvement activities, noncrop sites including industrial sites, rights-of-way (including roadsides, electric utility and communication transmission lines, pipelines, railroads, airports), irrigation and drainage ditches, canals, reservoirs, natural areas (including wildlife management areas, wildlife openings, wildlife habitats and refuges, parks and recreational areas, campgrounds, trailheads and trails), rangeland, and in and around aquatic sites and wetlands; also for perennial grass release, and grass growth suppression and grazed areas on these sites.

Avoid contact of herbicide with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees, because severe injury or destruction may result.

Active Ingredient:

glyphosate [†] N-(phosphonomethyl)glycine,	
isopropylamine salt	. 53.8%
Other Ingredients	. 46.2%
Total	100.0%

[†]Contains 5.4 lb per gallon glyphosate, isopropylamine salt (4 lb per gallon glyphosate acid).





Herbicide Toxicity

- Herbicides are "Toxins", but toxins to what?
- If they weren't toxic to plants, they would be useless
- But are they toxic to us or other organisms?

Types of toxicity and classifications

- Acute vs. Chronic
- Oral
- Dermal
- Inhalation
- Eye
- "Dose makes the poison" (e.g., drinking too much water can kill you)

Expression of toxicity

- LD50 (mg/kg) amount to cause death in 50% of test animals
- The bigger the number the better (less toxic)

Substance	LD50 (mg/kg)	Amount/155 lb person
Water	90,000	About 1.7 gallons
Table Salt	3,000	About 0.5 pound
Caffeine	367	About 270 cups of coffee
Nicotine	10	About 8 tins of chew
Glyphosate	10,000	About 1.5 quarts
Methyl Parathion	6	About 0.03 fl oz

What makes a given product "toxic"?

- Active ingredient
- Co-formulants



EPA Reg. No. 62719-40



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Starane			
		F	ex
With the second	AgroSciences I	16	
For postemerger (including durum	t control of a	annual broad s, rye and tri	leaf weeds in wheat licale.
Group	2	4	HERBICIDES
Active Ingredient: florasulam: N-(2,6	-difluorophenyl triazolo(1,5-c)py)-8-fluoro-5- yrimidine-2-	0 50%
methoxy (1,2,4) sulfonamide fluroxypyr 1-meth 3,5-dichloro-6-1 acetic acid, 1-m Other Ingredients Total.	ylheptyl ester: (fluoro-2-pyridin nethylheptyl est	(4-amino- yl)oxy) er	
methoxy (1,2,4) sulfonamide fluroxypyr 1-meth 3,5-dichloro-6-f acetic acid, 1-m Other Ingredients Total EPA Reg. No. 62719	ylheptyl ester: (fluoro-2-pyridin nethylheptyl est 1-604	(4-amino- yl)oxy) er	
methoxy (1,2,4) sulfonamide fluroxypyr 1-meth 3,5-dichloro-6-f acetic acid, 1-m Other Ingredients Total EPA Reg. No. 62719 Acid equivalent – flu Contains 0.042 lb of Contains petroleum	ylheptyl ester: (fluoro-2-pyridin nethylheptyl est I-604 roxypyr – 10.03 florasulam per distillates	(4-amino- yljoxy) er 	

Dow AgroSciences





A SELECTIVE WEED KILLER

Specimen Label

For control of many broadleaf weeds and brush control in corn (field, pop and sweet), sorghum (Milo), soybeans (preplant), small grains (barley, millet, oats, rye, wheat), rice, sugarcane, fallow land, grasses, stone fruits and nut orchards, brush control, pastures, rangelands, forest management and in noncrop areas such as lawns and ornamental turf, drainage ditchbanks, fence rows and rights-of-way. Also for aquatic weed control, control of trees by injection, and tank mixes.

ACTIVE INGREDIENT:

Dimethylamine Salt of 2,4	-Dichlorophenoxyacetic Acid* 47.2%
OTHER INGREDIENTS:	
TOTAL:	

Isomer Specific AOAC Method, Equivalent to:

*2,4-Dichlorophenoxyacetic Acid 39.2%, 3.8 lbs./gal.

EPA Reg. No. 81927-38



Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Label Signal Words

The Highest Signal Word

You won't need to deal with this one...

RESTRICTED USE PESTICIDE

DUE TO ACUTE TOXICITY FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

GROUP 22 HERBICIDE



syngenta.

Herbicide

A Weed, Grass, and Harvest Aid Desiccant/Defoliant Herbicide

Active Inaredient: Paraquat dichloride (1,1'-dimethyl-4,4'-

Other Ingredients: 69.9%

Total:

100.0% Gramoxone SL 2.0 contains 2.0 pounds paraquat cation per gallon as 2.762 pounds salt per gallon. Gramoxone SL 2.0 contains alerting agent (odor),



Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

· NEVER PUT INTO FOOD, DRINK OR OTHER CONTAINERS. . IF SWALLOWED, TAKE IMMEDIATE ACTION AS

- PRESCRIBED IN FIRST AID STATEMENT. SYMPTOMS ARE PROLONGED AND PAINFUL. DO NOT USE OR STORE IN OR AROUND THE HOME.
- DO NOT REMOVE CONTENTS EXCEPT FOR IMMEDIATE USE.

THE ODOR OF THIS PRODUCT IS FROM THE ALERTING AGENT WHICH HAS BEEN ADDED. NOT FROM PARAQUAT. EPA Reg. No.100-1431

EPA Est. 100-LA-001 Product of the United Kingdom Formulated in the USA

SCP 1431A-L1F 1115 4074780

2.5 gallons Net Contents



Imitator[®] Plus Herbicide

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PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear: Long-sleeved shirt and long pants, shoes plus socks, and chemical-resistant gloves (such as natural rubber, Selection Category A).

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

ENGINEERING CONTROLS

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USER SAFETY RECOMMENDATIONS

Do Herbicides Cause Cancer?

International Agency for Research on Cancer IARC Classifications: Group 1 (most carcinogenic), Groups 2A and 2B, Group 3, Group 4

IARC does not consider exposure and uses the "precautionary principle"

Group 1 includes alcoholic beverages and plutonium

Group 2A (probable carcinogens) includes red meat, very hot beverages, working the night shift, and **glyphosate**

Group 2B (possible carcinogens) includes Aloe vera, cell phones, and **2,4-D**

Most international regulatory bodies do not use IARC methodology and do not classify either glyphosate or 2,4-D as carcinogens

Safety

- Personal Protective Equipment (PPE)
 - Gloves
 - Eye protection
 - Pants
 - Shoes
- PPE is essential for safe use
- Must be used correctly
- Tailored to the herbicide being used

PRECAUTIONARY STATEMENTS Hazards to Humans and Domestic Animals

DANGER: Corrosive. Causes irreversible eye damage. Harmful if swallowed. Do not get in eyes or on clothing. Avoid breathing vapor or spray mist

PERSONAL PROTECTIVE EQUIPMENT (PPE)

All mixers, loaders, flaggers, other applicators and handlers must wear: Long-sleeved shirt and long pants, shoes plus socks, chemical-resistant gloves such as barrier laminate, butyl rubber ≥ 14 mils, nitrile rubber ≥ 14 mils or viton ≥ 14 mils, protective eyewear (goggles, safety glasses or face shield), and chemical-resistant apron when mixing or loading, cleaning up spills or equipment, or otherwise exposed to the concentrate.

See Engineering Controls for additional requirements.

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry. After each day of use, clothing or PPE must not be reused until it has been cleaned.

Environmental Concerns

Drift- Air Movement off from intended site of application

- To non-target plants
- To sensitive areas (eg. water)
- By droplets
- By vapor

Runoff (for soil active herbicides)

Movement through soil

Translocation – "Hitching a ride"

- For perennials you need to kill the roots, and for that you need translocation
- Amount and direction of translocation
- Factors:
 - Time of year
 - Stage of plant
 - Temperature
- Most herbicides for invasives are translocated

□ SITE OF ABSORPTION AND TRANSLOCATION



Soil-activity and root uptake

- Depends on the herbicide, some have foliar and root uptake (e.g. Tordon)
- Sometimes helpful, sometimes not





□ SITE OF ABSORPTION AND TRANSLOCATION



Application – Getting it to the right place (and not the wrong one)

- Herbicide solution has to hit the target and make its way into leaves, stems, and/or bark
- Types of applications:
 - Foliar (drift can be an issue)
 - Cut stump
 - Basal
 - Hack and squirt



Application Equipment – Foliar Sprays

- Hand sprayers
- Backpack sprayers
- Tractor/ATV





Nozzles



- A topic that can get complicated very quickly
- Most common hand sprayers have an adjustable conetype
- Adjust for a coarse spray to reduce drift. Most translocated herbicides will work fine with this setting.
- Some backpack sprayers and most boom sprayers will use interchangeable nozzles



Cut-Stump

- Invasive brush, like zombies, keeps coming back from the dead
- What to treat with (glyphosate, triclopyr)
- When to treat (immediately after cutting)
- How to treat (cover entire cut surface)







Basal Bark Treatment

- Requires diesel or basal oil carrier
- Triclopyr and triclopyr + 2,4-D ester formulations are best
- Works best on small (<6"), smooth-barked species

Hack and Squirt



- Can be effective on larger trees and brush
- Need to do the "squirt" shortly after the "hack"
- Good if you don't care if the dead brush is left standing

Photo: University of Florida

Calibration:

Getting the right amount

Too little and target may recover

Too much wastes product and may harm surrounding plants

Essentially is amount of product per unit area (e.g. pints/acre)

For many invasive plant applications it's a matter of percent solution and "spray to wet"

Formulas

- There are many formulas for calibration
- Can get complicated
- Sometimes intuitive math is best

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1/128 Method of Calibration -Calibrating Single Nozzle Hand Sprayers

- 1. Measure an area of 1/128th of an acre (18.5 X 18.5 ft)
- 2. Time how long it takes to spray that area with water
- 3. Spray water into a bucket for that amount of time
- 4. Measure the output in ounces.
- 5. Number of ounces = Gallons per Acre (GPA)

- Let's say method in previous slide determines sprayer output of 40 GPA
- A fact sheet tells me to use 1 pound a.e. of 2,4-D per acre
- My label says each gallon of product contains 3.8 lb a.e. of 2,4-D (let's round up to 4, so each quart contains 1 lb a.e. of 2,4-D)
- My sprayer holds 1 gallon, so I'm spraying 1/40th of an acre and therefore need to add 1/40th of a pound a.e. of 2,4-D
- 1 quart divided by 40 = 0.025 quart (about 24 ml)

How much product to put in the sprayer?

What should I do if it rains?

Herbicide effectiveness can be influenced by rainfall after application

- What product?
- How much rain and intensity (A quick ¼ inch vs. a light mist)?
- How much elapsed time?
- > 0.1 inch in less than an hour probably will require re-application

Product	Rainfast Interval	Comments
Glyphosate	1-6 hours	Reapply if heavy rain w/in 2 hours
2,4-D amine	6-8 hours	
2,4-D ester	1 hour	
Triclopyr (Garlon)	6 hours	May be shorter for ester formulations
Picloram (Tordon)	2 hours	

Additives

- Adjuvants
- Deposition aides
- Dyes

Timing (it is everything)

- Plant stage
- Time of year



HOW TO CLEAN YOUR SPRAYER

- Spray out all herbicide solution
- Fill with clean water
- Shake and empty tank (spray out on a proper area)
- Refill with water and a few drops of dish soap or a splash of ammonia
- Shake and empty the tank
- Refill, shake, and spray out



What Product Do I use?

- Hopefully, the previous topics have provided some clues
- There is a lot of good information out there <u>if you</u> <u>know where to look</u>



Forestry and Natural Resources purdue.edu/fnr

FNR-633-W



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INVASIVE PLANT SERIES

Phase a contract of a

Tree of Heaven, Ailanthus altissima

https://extension.purdue.edu/extmedia/FNR/FNR-633-W.pdf



Japanese Barberry

(Berberis thunbergii)

Dave

https://extension.psu.edu/japanese-barberry



Asian Bittersweet

Celastrus orbiculatus

https://renzweedscience.cals.wisc.edu/

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Questions and Discussion

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