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Dealing with abiotic injuries: When the pest is not a pest…

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Presentation outline

- Common abiotic problems in Christmas tree production
- Characteristics of abiotic plant problems
- Options for dealing with abiotic issues

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Abiotic vs Biotic Issues

- May occur in a pattern
- Often associated with a specific event
- Multiple species affected

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Dealing with abiotic issues

- Protection/Prevention
- Modify the site
- Selection

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Common abiotic issues

- Winter injury
- Heat/drought
- Flooding
- Herbicide
- Nutrition*

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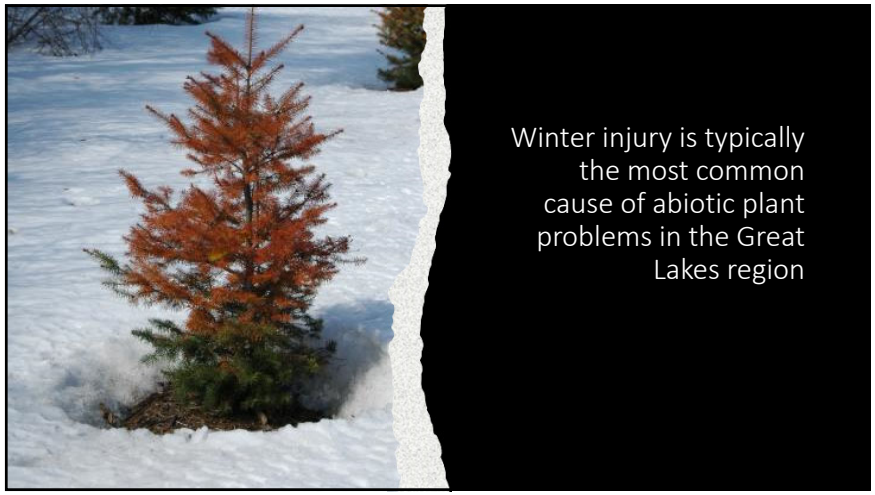

Winter injury is typically the most common cause of abiotic plant problems in the Great Lakes region

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Forms of winter injury

- Freezing damage
  - Early
  - Mid
  - Late
- Winter desiccation
- Salt damage
- Snow and ice breakage
- Animal damage

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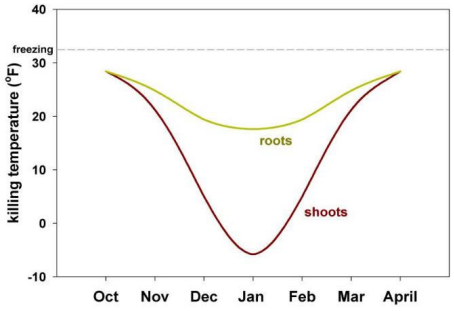
"Typical" pattern of cold hardiness of conifers



Adapted from Ritchie 2002

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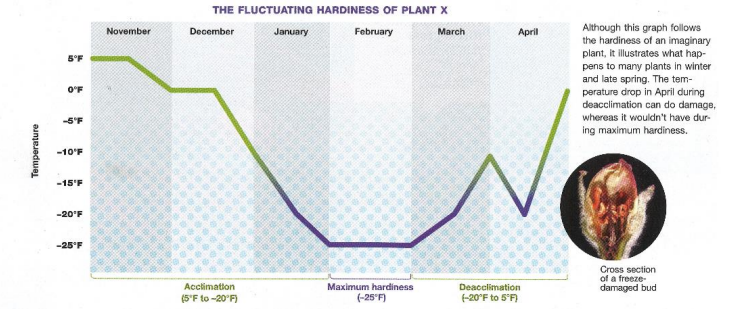
"Typical" pattern of cold hardiness of conifers



Cregg, Fine Gardening Feb. 2013

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Early winter injury

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Mid-winter injury

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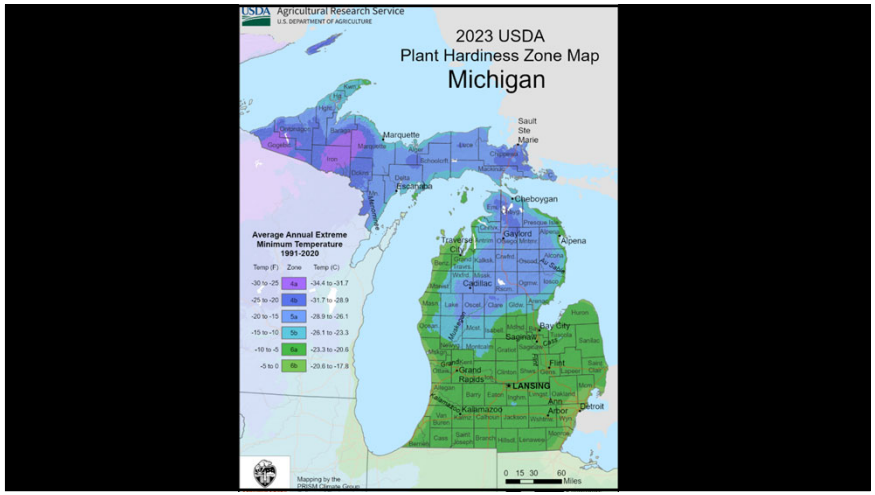
USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE
2023 USDA
Plant Hardiness Zone Map
Michigan
Average Annual Extreme Minimum Temperature 1991-2020
Temp (F) Zone Temp (C)
-30 to -25 4a -34.4 to -31.7
-25 to -20 4b -31.7 to -28.9
-20 to -15 5a -28.9 to -26.1
-15 to -10 5b -26.1 to -23.3
-10 to -5 6a -23.3 to -20.6
-5 to 0 6b -20.6 to -17.8
Marquette
Sault Ste Marie
Cheboygan
Alpena
Traverse City
Gaylord
Cadillac
Bay City
Saginaw
Flint
Grand Rapids
LANSING
Kalamazoo
Ann Arbor
Detroit
0 15 30 60 Miles
Mapping by the PRISM Climate Group

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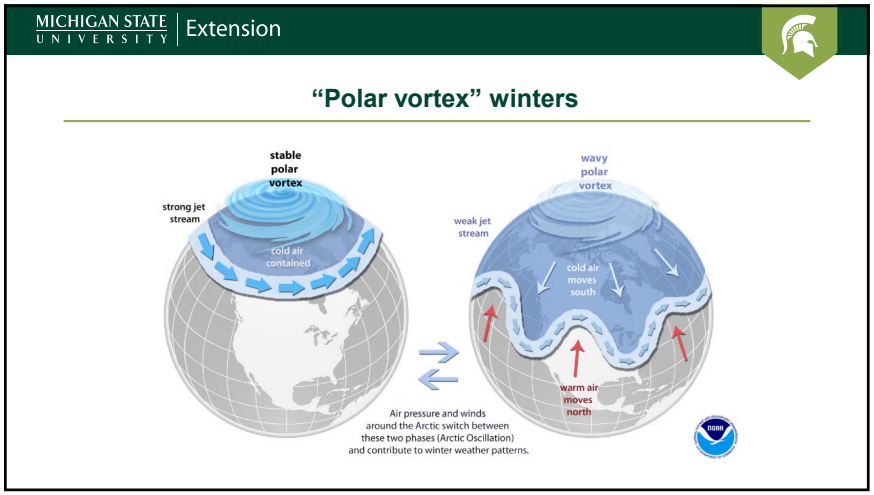
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"Polar vortex" winters
stable polar vortex
strong jet stream
cold air contained
wavy polar vortex
weak jet stream
cold air moves south
warm air moves north
Air pressure and winds around the Arctic switch between these two phases (Arctic Oscillation) and contribute to winter weather patterns.

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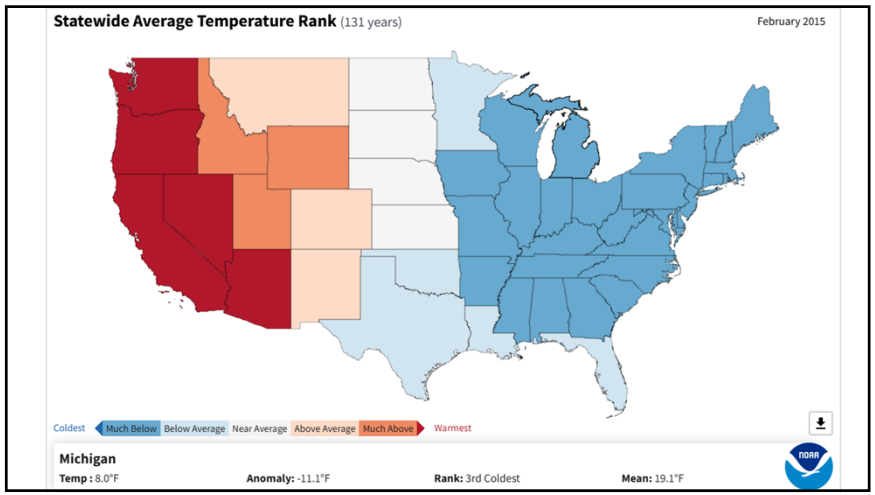
Statewide Average Temperature Rank (131 years)
February 2015
Coldest
Much Below
Below Average
Near Average
Above Average
Much Above
Warmest
Michigan
Temp : 8.0°F
Anomaly: -11.1°F
Rank: 3rd Coldest
Mean: 19.1°F

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Undamaged bud
Bud killed by freezing

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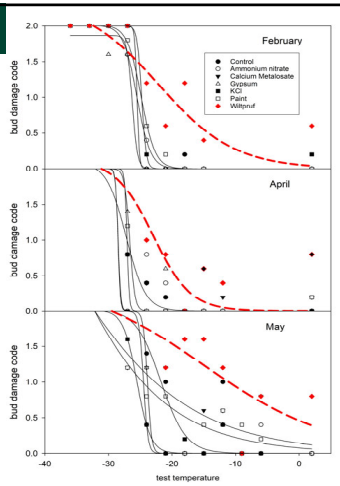
Are there treatments to improve cold hardiness?

Probably not.

But most practices won't hurt it either.



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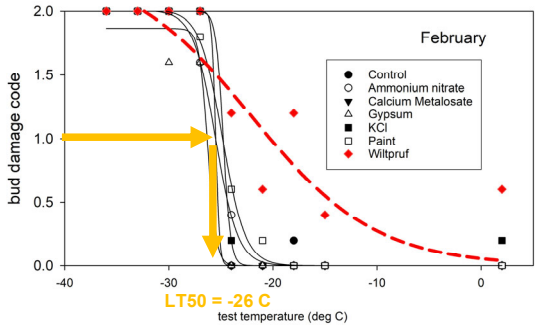
Cold hardiness testing – Blue spruce



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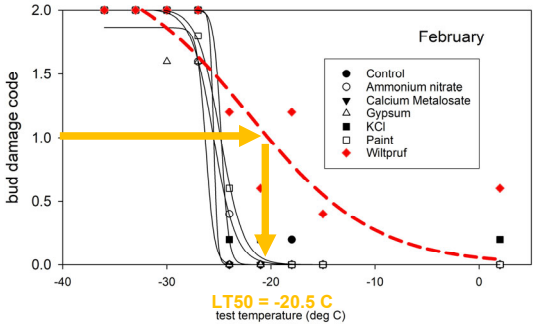
Cold hardiness testing – Blue spruce



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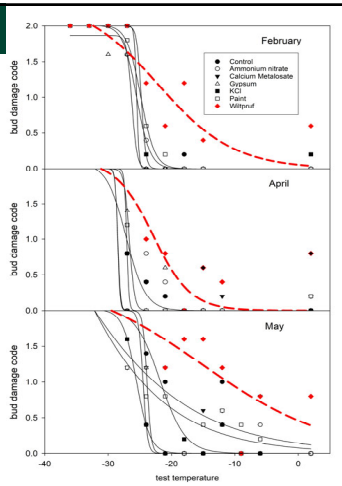

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Late frost damage

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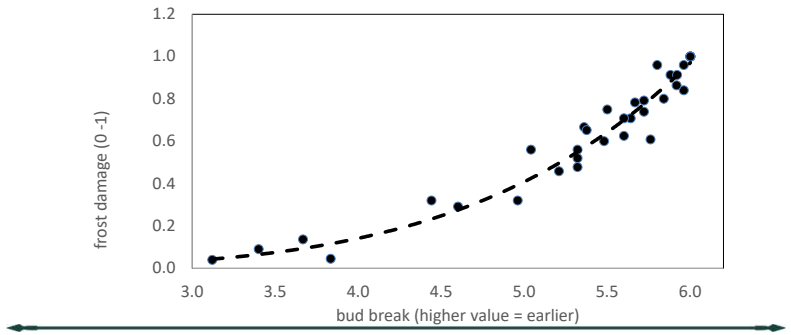
Relationship between frost damage and budbreak



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Budbreak variation

Early budbreak (most risk)
- Corkbark fir
- Turkish fir
- Balsam fir
- Concolor

Late budbreak (least risk)
- Fraser fir
- Korean fir
- Veitch fir

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Badger – July 2025

- Possible late frost events June 1 & 2

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Late frost damage at Badger – Spring 2025

	Number	Percent
No mulch	81/300	27%
Mulch	28/300	9%

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Types of Winter injury

Winter desiccation

- Occurs when temperatures warm enough to cause transpiration
- Soil water is frozen and plants cannot replace water lost to transpiration

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Deicing salt damage

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Deicing salt damage

- Direct toxicity
  - Cl and Na are both toxic at high levels
- Osmotic stress
  - NaCl reduces soil water potential"Fertilizer burn"
- Reduced cold hardiness
- Method of exposure
  - Road spray/splash – acute injury
  - Soil accumulation – chronic injury

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Mammal damage

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Deer browse

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Deer strategies

- Hunting
- Fencing
- Deterrents
- Repellants

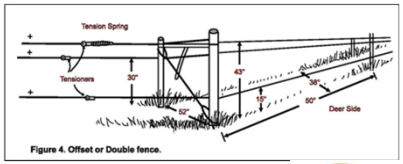

Figure 4. Offset or Double fence.

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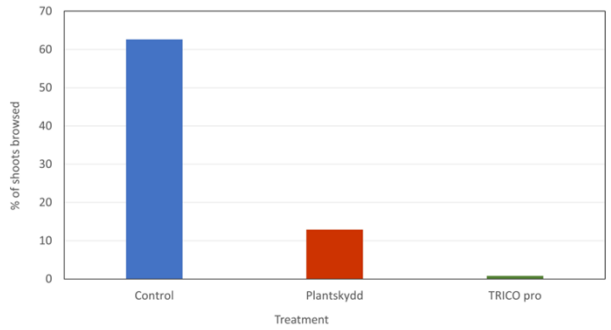
MSU Deer repellant trial



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Species selection

Highly preferred
- Fraser
- Turkish

Less preferred
- Spruces
- Concolor fir
- Korean fir

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Poor drainage/flooding

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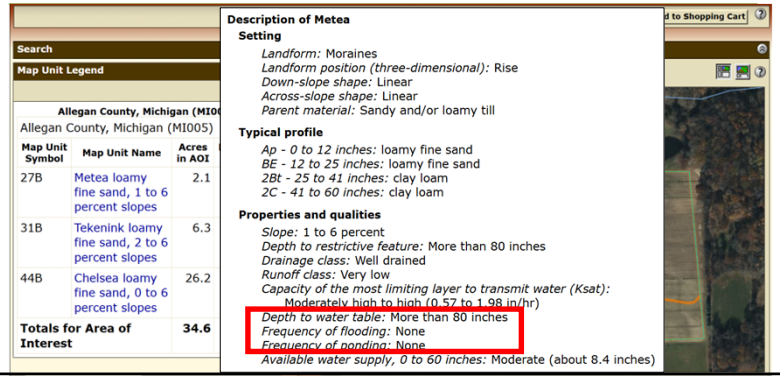

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Heat and drought

- Direct injury from high temperatures is relatively rare
- Drought stress is a result of soil moisture status and atmospheric conditions (VPD)
- Drought stress is especially critical during establishment i.e., transplant stress

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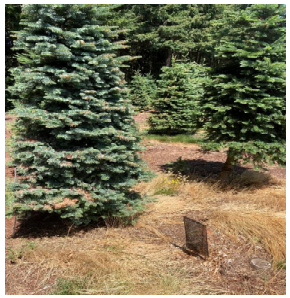
Examples of damage from 2021 Heat dome event in PNW (Chal Landgren OSU)

- Types of damage (harvest size)
  - S. side of tree- red needles on current season age-class needles
  - S. side of tree- last years needles red and damaged (current season needles OK)
  - Top whorls with dead needles all the way around the tree
  - Wilted-dead current season growth
  - Wilted tops



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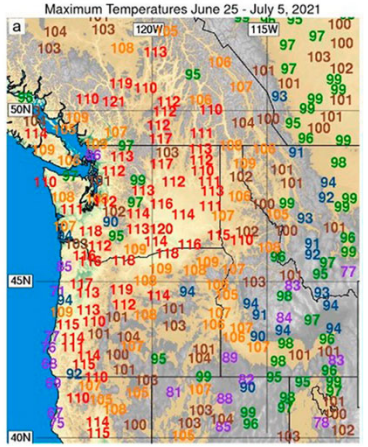
2021 PNW Heat Dome



Mass et al. 2024

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Noble fir damage types

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Turkish fir damages (NWREC)

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Turkish fir damages (NWREC)

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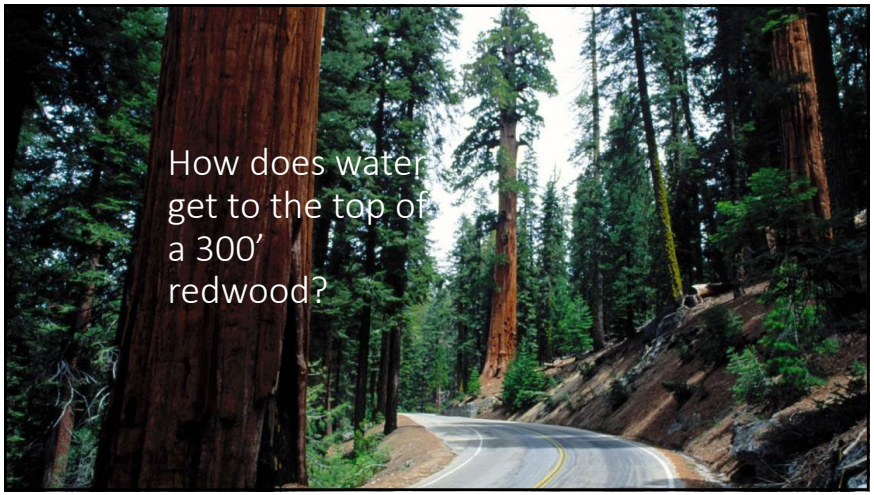
How does water get to the top of a 300’ redwood?

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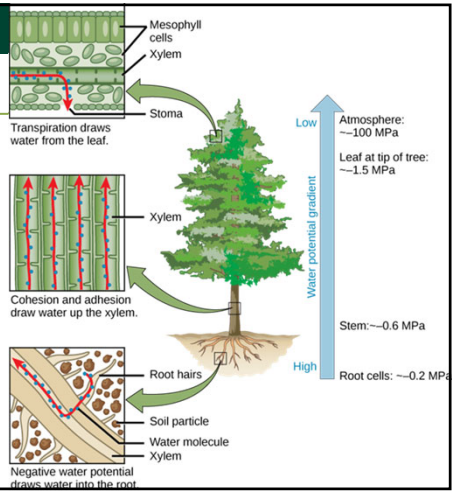
Soil

Plant

Atmosphere Continuum



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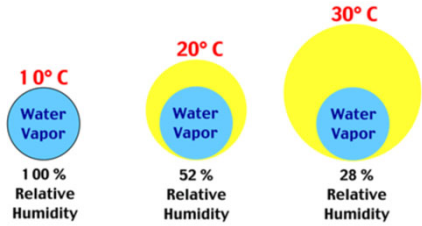
Understanding Vapor Pressure Deficit (VPD)

Actual Vapor Pressure: amount of water vapor in air

Saturation Vapor Pressure: amount of water vapor air can hold at a given temp

VPD = Saturation VP – Actual VP

RH = Actual VP/Saturation VP x 100



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Irrigation

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Reference PET

Standardized measurement of water loss from a well-watered, short grass surface

Estimated from:

- Temperature
- Solar radiation
- Windspeed
- Relative humidity

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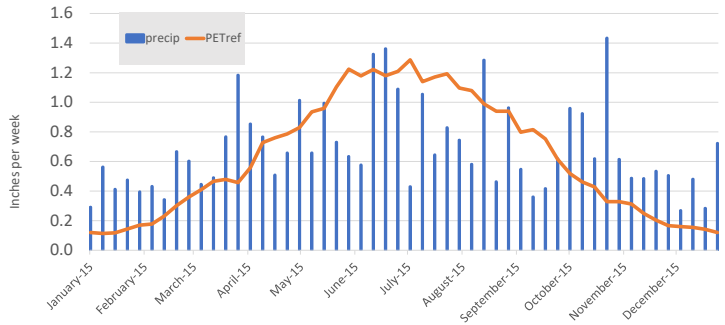
Mean weekly PETref and precip – Allegan 2015-2025



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Effect of soil texture on plant available water

- Sandy soils have large pores and quickly lose water to gravity (low field capacity)
- Clay soils hold large amount of water too tightly to be available (high wilting point)
- Loams provide highest plant available water

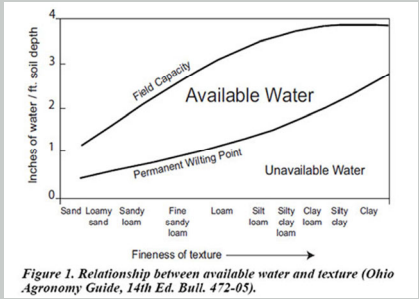

Figure 1. Relationship between available water and texture (Ohio Agronomy Guide, 14th Ed. Bull. 472-05).

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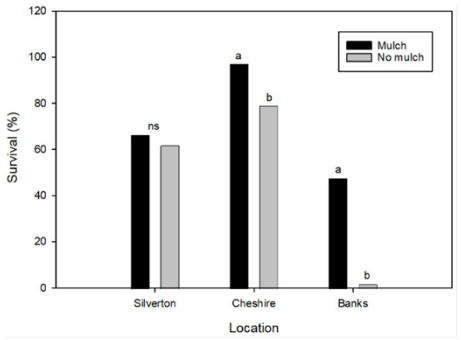
Mulch impacts on survival

OSU Noble fir trial

- Mulch increased overall survival
- At one farm increased survival from 3% to 50%



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MSU Mulch trials

Mulch

- Conserves soil moisture
- Moderates soil temperature
- Reduces wee competition
- Increases growth
- Increases survival

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Common Causes and Symptoms

- Glyphosate (Roundup): Causes twisting, stunted growth, and yellowing, often due to drift or direct application to foliage.
- Goal (Oxyfluorfen): Can cause significant, though sometimes temporary, needle burn.
- Stinger (Clopyralid): Over-application can cause severe twisting.
- Timing Errors: Applications made during active spring growth or with improper, fine droplets increase injury risk.
- Drift: Volatile herbicides like 2,4-D and dicamba can cause deformed foliage and branch dieback

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Management and Prevention

- Timing: Apply herbicides before bud break in the spring or after growth has hardened in the fall.
- Application Method: Use directed sprays, shielding, or equipment like Mankar sprayers to avoid hitting tree foliage.
- Environmental Factors: Avoid spraying on windy days to prevent drift.
- Alternatives: Utilize mulch as a barrier to reduce weed pressure without chemical application

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SPRAY DRIFT MANAGEMENT

The interaction of many equipment- and weather-related factors determines the potential for spray drift. The applicator is responsible for considering all these factors when making application decisions. Avoiding spray drift is the responsibility of the applicator.

IMPORTANCE OF DROPLET SIZE

The most effective way to reduce drift potential is to apply large droplets (greater than 150–200 microns). The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. The presence of sensitive species nearby, the environmental conditions, and pest pressure may affect how an applicator balances drift control and coverage. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly or under unfavorable environmental conditions! See the Wind, Temperature and Humidity, and Temperature Inversions sections below.

CONTROLLING DROPLET SIZE
GENERAL TECHNIQUES

- **Volume** - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- **Pressure** - Use the lower spray pressures recommended for the nozzle. Higher pressure reduces droplet size and does not improve canopy penetration. When higher flow rates are needed, use a higher-capacity nozzle instead of increasing pressure.
- **Nozzle Type** - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles.

CONTROLLING DROPLET SIZE - AIRCRAFT

WIND

Drift potential increases at wind speeds of less than 3 mph (due to variable direction and inversion potential) or more than 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given wind speed. AVOID GUSTY OR WINDLESS CONDITIONS.

Note: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they effect spray drift.

TEMPERATURE AND HUMIDITY

When making applications in hot and dry conditions, set up equipment to produce larger droplets to reduce effects of evaporation.

SURFACE TEMPERATURE INVERSIONS

Drift potential is high during a surface temperature inversion. Surface inversions restrict vertical air mixing, which causes small suspended droplets to remain close to the ground and move laterally in a concentrated cloud. Surface inversions are characterized by increasing temperature with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates a surface inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

SHIELDED SPRAYERS

Shielding the boom or individual nozzles can reduce the effects of wind. However, it is the responsibility of the

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Preventing herbicide damage

- Drift
  - Particles
  - Vapor
- Soil
  - Uptake
  - Movement

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Minimizing drift

- Wind
  - <10 mph
  - Spray with wind
- Particle size
  - Maximum nozzle size
  - Minimum pressure

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Particle Drift

	Feet traveled in
Droplet type	3 mph wind
Fog	15,840
Very fine	1,100
Fine	44
Medium	28
Course	9
Fine rain	5

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