Integrated Weed Management Program for Golf Courses

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II. Weed Biology
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VIII. Resistance Management

I. Types of Turfgrass weeds

- **Annual grasses**
- **Annual broadleaf weeds**
- **Perennials**

Yellow nutsedge (*Cyperous esculentus*)

- **Perennial sedge**
- **Reproduction primary by tubers**
- **3 angled erect stem**
- **leaves long, 3 ranked and yellowish green in color.**

Yellow nutsedge (*Cyperous esculentus*)

Seedlings

Common Dandelion (*Taraxacum* officinale)

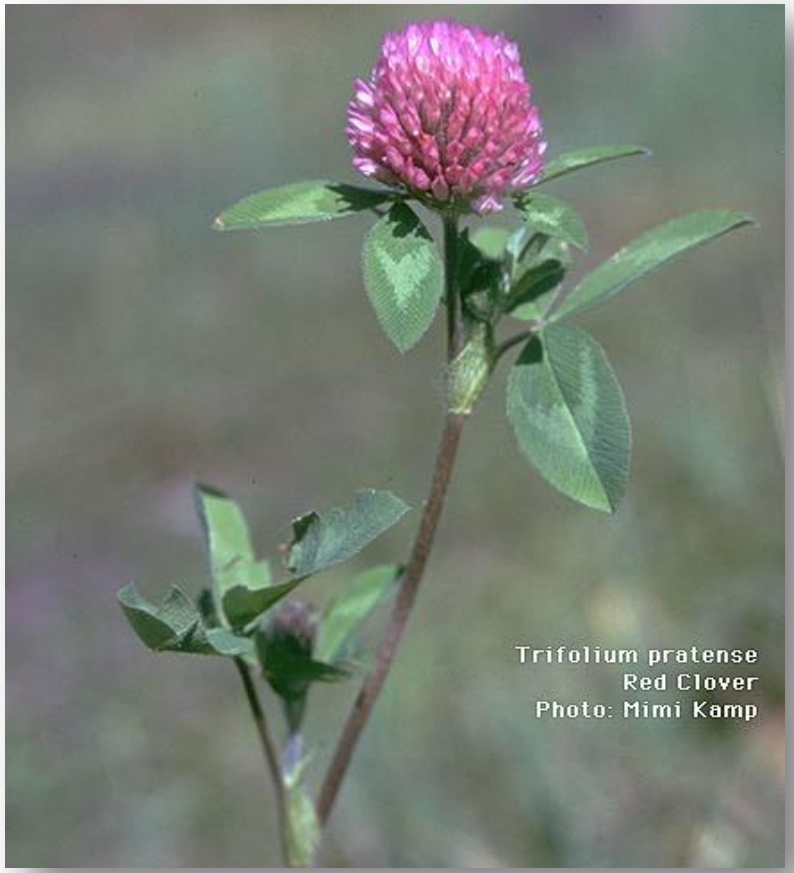
White Clover (*Trifolium repens*)

- **Trifoliate**
- **Pale triangular mark on leaflets**

White Clover (*Trifolium repens*)

- **Flower and leaves grow on separate stalks**
- **Flower heads white**

Red Clover (*Trifolium pratense*)



Black medic (*Medicago lupulina*)

Green Kyllinga (*Kyllinga brevifolia*)

Annual Bluegrass (*Poa annua)*

II. Weed Biology

USING KNOWLEDGE OF WEED BIOLOGY

WEED IDENTIFICATION

KNOW YOUR WEEDS

- **Family**
- **Life cycles**
- **Other biological classes**
    - Efficient vs Non-efficient (C4 vs C3)

COMPARISON OF KENTUCKY BLUEGRASS AND CRABGRASS

FACTORS	BLUEGRASS	CRABGRASS
CO_2 Fixation cycle	C3	C4
CO_2 Uptake	Light saturation	Light saturation
Increases with light intensity	1000 TO 3000 Ft Candles	5000 Ft Candles
Rate (mg CO_2 /sq dm/hr)	15 to 35	50 to 80

COMPARISON OF KENTUCKY BLUEGRASS AND CRABGRASS

FACTORS	BLUEGRASS C3	CRABGRASS C4
TEMPERATURE OPTIMUM	10 TO 25 C	30 TO 40 C
PHOTO-RESPIRATION	YES	NO
WATER REQUIREMENT	2 TO 3 Times	1 unit

COMPARISON OF KENTUCKY BLUEGRASS AND CRABGRASS

FACTORS	BLUEGRASS C3	CRABGRASS C4
OXYGEN (inhibition of photosynthesis)	Not known	No effect
COMPENSATION POINT (photosynthesis)	30 ppp CO_2	5 ppm CO_2

IMPORTANCE OF REPRODUCTION

- Reproduction strategy
- Seed production
- Vegetative propagules

IMPORTANCE OF WEED SEED BANK?

- What is seed bank?
- Why is it so important?
- How does it relate to weed management?

III. IPM CONCEPTS

- **WHAT IS IPM?**
- **HOW CAN WE USE THIS CONCEPT IN WEED MANAGEMENT?**

IV. Cultural Practices

- **Alleviate soil compaction**
- **Deep and infrequent irrigation**
- **Maintain pH at 5.5-6.5**
- **Eliminate *Poa annua* in rough areas**

Steps for Reducing Poa annua Competition

1. **Avoid excessive irrigation**
2. **Avoid excessive N fertilization**
3. **Clipping removal**
4. **Proper mowing height**

PRIMARY CULTURAL PRACTICES

- ESTABLISHMENT
- MOWING
- IRRIGATION
- FERTILIZATION

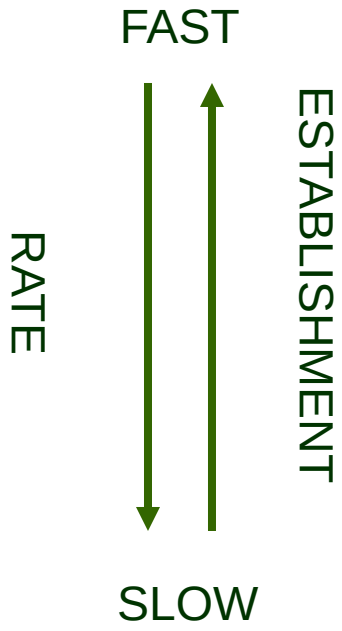
Supplemental Cultural Practices

- **Cultivation**
  - **Core cultivation**
  - **Water injection**
  - **Slicing and spiking**
  - **Vertical mowing**
  - **Rolling**

TURFGRASS ESTABLISHMENT

- **NEWLY SEEDED AREAS**
  - **Type of turfgrass species**
  - **Density – seeding rate**

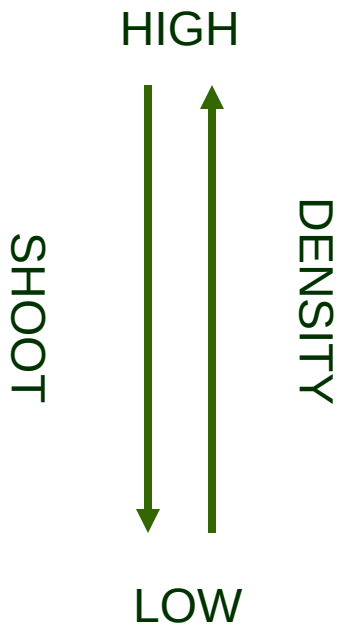
Establishment Vigor of Popular Turfgrasses



Cool season	Warm season
Perennial ryegrass	Bermudagrass
Tall Fescue	Saint Augustinegrass
Fine fescues	Bahiagrass
Creeping bentgrass	Centipedegrass
Colonial bentgrass	Carpetgrass
Kentucky bluegrass	Zoysiagrass

Source: A.J. Turgeon (1980)

Shoot Density of Popular Turfgrasses



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SEEDINIG

- **Benefits**
  - **Important part of reducing wear**
  - **Cheaper than sodding**
  - **Can seed the whole season by high quality seed to fit your program**

SEEDING

- Types of seeding
  - Broadcasting
  - Slit seeding
  - Divot mix
  - Pre-germinated seed

TURFGRASS ESTABLISHMENT

- **SODDED AREAS**
  - **Type of sod**
  - **Placement**

SODDING

- Quick repair in a short amount of time
- Expensive and labor intensive
- Develop sod nursery

MOWING PRACTICES

MOWING VARIABLES

- Mowing height
- Mowing pattern
- Clippings
  - small fragments
  - large fragments

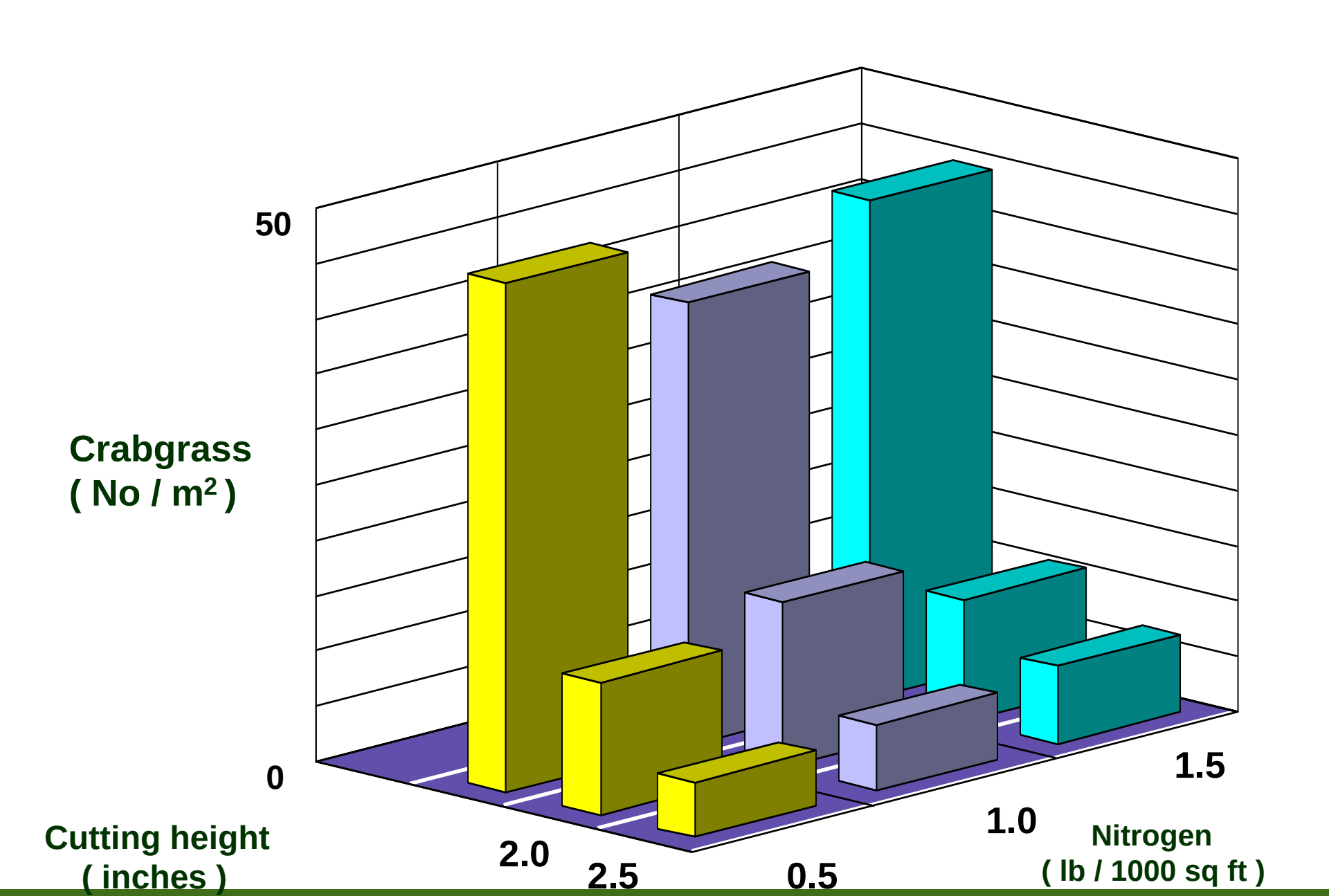
Recommended Turfgrass Mowing Heights Under General Agronomic Practices for Cool Season Species

Turf	Mowing Height (cm)	Mowing frequency [a] (days)
Creeping bentgrass	0.6-1.2	3-4
Perennial ryegrass	3.8-6.2	5-7
Kentucky bluegrass	3.8-6.2	5-7
Red fescue	3.8-6.2	5-7
Tall fescue (KY 31)	5.0-10.0	7-14
(turf types)	3.8-7.5	5-7

- **Mowing frequency should be adjusted so that no more than one-third of the leaf area is removed per mowing.**

Cultural control of crabgrass

- **Dernoeden etal. (1994) found mowing height of 3.5 inches of tall fescue was effective in controlling smooth crabgrass compared to 1.25 or 2.2 inches.**
- **Murrey etal. (1983) found increasing rates of nitrogen decreased percent smooth crabgrass in Kentucky bluegrass.**



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IRRIGATION PRACTICES

- METHODS
- TIMING
- FREQUENCY
- INTENSITY
- WATER QUALITY

FERTILIZATION PRACTICES

- **NUTRIENT REQUIREMENTS**
  - Species
  - Site

FERTILIZATION PRACTICES

- **NUTRIENTS**
  - Macro nutrients: N, P, K, Ca, Mg
  - Micro nutrients: Fe, B, Mn, Cu, Zn

FERTILIZATION PRACTICES

- Balanced program: use soil tests
- Frequency and timing
- Extra application in the high wear areas

SUPPLEMENTAL CULTURAL PRACTICES

- CULTIVATION
- TOP DRESSING

Methods of Aerification

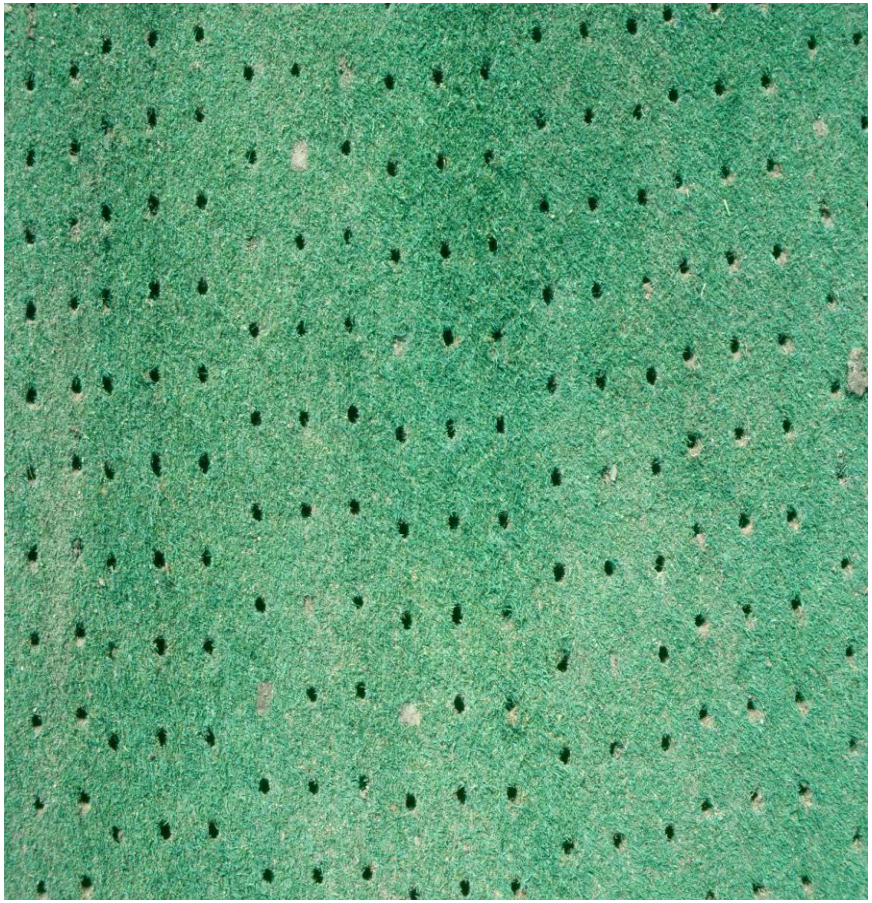
- Core/Hollow Tine Aerification
- Solid Tyne Aerification
- Slicing/Spiking Aerification
- Deep-tine Aerification

Methods of Aerification

- Vertical Mowing
- Rolling
- Water injection

AERIFICATION

- **Grass seed placement**
- **Amendment of existing soil**



AERIFICATION

- Reduces compaction
- Introduces oxygen to roots for healthier plant
- Increase water infiltration

AERIFICATION

- **Maintains thatch layer**
- **Grass seed placement**
- **Amendment of existing soil**

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TOPDRESSING PRACTICES

- LAYERING
- SELECTION OF TOPDRESSED MATERIALS
- INTENSITY OF TOPDRESSING

TOP DRESSING

- **Top dressing material**
- **Topdress after seeding in high wear areas to cover up the seed and keep area level**

TOP DRESSING

- **Benefits**
  - Leveling low spots in fields
  - Seed to soil contact
  - Maintain thatch layer
  - Protect turfgrass from winter desiccation
  - Amend soil medium

V. Biological Control

Xanthomonas campestris pv. *poannua*

- **Selective, postemegrence bioherbicide for control of *Poa annua***
- **Enters plant through mowing wound**
- **Multiplies in vascular system, clogging xylem with cells and EPS – vascular wilt**
- **Occurs slowly, allowing desirable species to fill in voids**

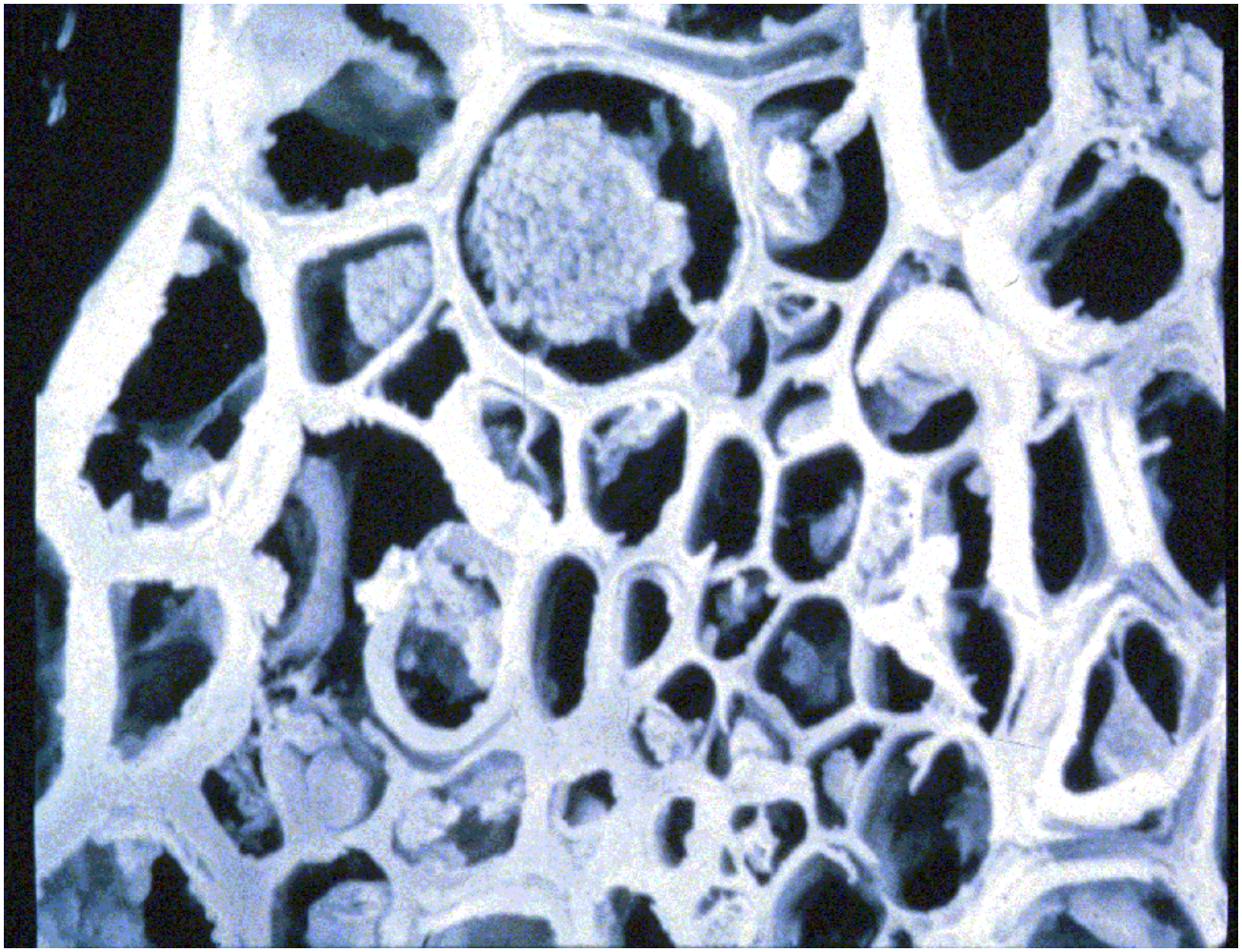
Xanthomonas campestris

- **Specific to annual bluegrass**
- **Safe to other turfgrass species**
- **Apply 3.8 L product per 380 L water**
- **Apply to turfgrass and then mow**
- **Apply only during the morning and evening**
- **Usually takes 4 to 5 applications**

XPo™

- **Micro-organism:** ***Xanthomonas campestris*** **pv.** ***Poannua***
- **Formulation:** ***Xanthomonas*** **and inert material**
- **Mode of Action : Plugs up the xylem with xantham gum**
- **Effects: Selective control of Annual Bluegrass (*Poa* annua) in desirable turfgrass species**
- **Symptoms: Etiolation and wilting of leaves**
- **Optimum Environmental Conditions: Infection at 65 to 80˚F followed by a high temperature stress period.**

XPo™



Xylem vessels plugged with xantham gum

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XPo™

Untreated

Xpo™ Treated

Flags in the picture represents individual *Poa* colony

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VI. Chemical Control

Mode of Action

- **The mode-of-action is the overall manner in which a herbicide affects a plant at the tissue or cellular level. Herbicides with the same mode-of- action will have the same translocation (movement) pattern and produce similar injury symptoms.**

Site of Action

- **The location at which herbicides exert their toxicity at the cellular level is called the site of action.**

Pre-emergence application

- **Best time to apply**
- **Apply at recommended rate**
- **Repeat application?**

Common products

- **Most effective**
- **BARRICADE (Prodiamine)**
- **DIMENSION (Dithiopyr)**
- **Other preemergence herbicides**
  - Pendimethalin, Oryzalin

Fall Application Strategies

- **Primarily targeted for annual grass weed control**
- **Apply in the fall**
  - Do not apply once the ground is frozen

Postemergence application

- Growth stage of weeds
- Must be actively growing
- Repeat application?