Allelopathy

Weston and Inderjit in Upadyaya and Blackshaw (2007); Liebman et al. (2001);
Cecile Bertin et al., PNAS 104:16964-16969

Objectives:

1. To expose students ways in which allelopathy can be used in organic and sustainable agriculture.
2. To provide students with examples of allelopathic plants and allelochemicals.

Definition: The production and release of chemicals by plants or their residues that are toxic to other plants is termed allelopathy.

Applications for weed management:

1. Allelopathic cover crops
2. Allelochemicals as natural herbicides
3. Allelopathic crop cultivars.

Demonstrating allelopathy in the field is difficult:
Residues can modify nutrient, temperature, moisture, and light conditions. Difficult to distinguish those effects from residue-derived chemicals.

Creamer 1996 used leached and unleached residues.

Small-seeded weeds and crops more sensitive.

Residues of several grain crops reduced emergence of lettuce radish and tomato but increased the emergence of cucumber, pea and snap bean.

2 possible mechanisms:

1. Smaller seeded spp. Have a larger surface to volume ratio than larger seeded species. This can result in greater uptake per unit mass of allelochemicals.

2. When residues are used as a mulch the toxins are released into the soil surface may be confined to a shallow zone near the surface. This is the zone from which small-seeded weeds or crops must germinate in order for successful emergence. Large –seeded crops are planted deeper and germination and initial root growth occur below the allelopathic zone.

Production and decomposition of allelochemicals can vary.
Affected by soil and climatic factors, eg, allelochemical production in rye is greater under medium and low fertility than under high fertility.

Black walnut – *Juglans nigra*
Produces juglone – in bark shoots, roots, and nuts. Released by the roots into the soil. Soil type, density, planting distance, and time of walnut removal affect how long the phytotoxicty persists. Selective – many species susceptible, some spp. tolerant

Rice:
Some cultivars have been demonstrated to be suppressive of barnyard grass, duck salad (*Heteranthera limosa*); *Ammannia coccinnea*, *Cyperus difformis*.
Little or no attention by plant breeders to selection for allelopathic or weed-suppressive crop species.

Wheat and Barley:
Evidence of greater potential for allelopathy in older landraces than newer higher yielding accessions. Potential for lodging also greater in the newer cultivars. Applicable to organic producers.

Landscape ground covers and turfgrasses:
Nepeta spp (catmint)
Solidago spp. ornamental goldenrod.
Perennial ryegrass (*Lolium perenne*)

Fine fescues eg *Festuca rubra* (Cecile Bertin et al., PNAS 104:16964-16969)
Produce an aqueous phytotoxic root exudate
Meta-tyrosine (m-tyrosine); nonprotein amino acid.
Inhibits a wide range of plant species
Found in only one other plant species, *Euphorbia myrsinites*. (Rehak and Jander, 2007)

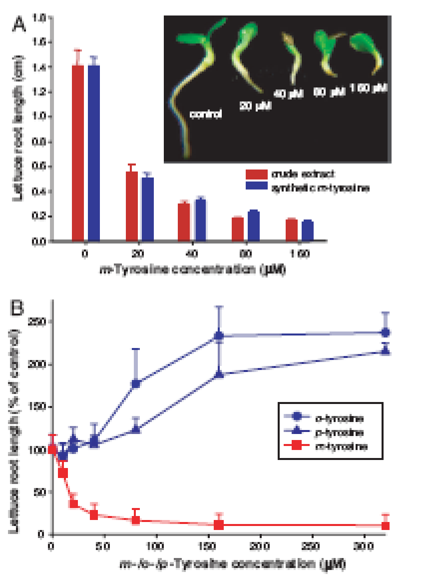

Fig. 3. Effect of *m*-tyrosine on lettuce. (*A*) Comparison of the effect of *F. rubra* cv. Intrigue aqueous root exudate extract and authentic *m*-tyrosine on lettuce (*L. sativa*) seedling root growth (9). (*Inset*) Photograph of 3-day-old lettuce seedlings exposed to various concentrations of aqueous root exudate extract, showing stunted growth and discoloration of root tips. (*B*) Effect of o-, *m*-, and *p*-tyrosine on lettuce seedling radicle elongation (9).

Applications for allelopathy in weed management

Cultural approaches:

- Allelopathic crops
- Rotation with allelopathic cover crops; use of allelopathic crop residues and seed meals

Natural Product Herbicides

- Growing interest in new herbicides with that are safer in terms of toxicology and environmental impact.

Need for new modes of action

- Use of allelochemicals in the design of synthetic herbicides