I. PLANT INTERACTION IN AGROECOSYSTEMS ALLELOPATHY

A. WHAT IS ALLELOPATHY

1. (AS DEFINED IN RICES' BOOK ON ALLELOPATHY): Allelopathy is the biochemical interactions between all types of plants including microorganisms.

2. Important point on allelopathy involves the addition of something to the environment, thus separated from competition, which involves removal of requirements for growth (light, water and nutrients).

B. METHODS OF ALLELOPATHIC AGENTS ENTERING THE ECOSYSTEM

1. Volatile vapor/gasses are released into the air surrounding the plants. Most significant to arid and semi-arid zones.
   a) e.g. Salvia leucophylla produces volatile terpenes that suppress plants.
   b) Mock orange recently reported to have toxins in the bark. Orchids died when placed in branches even when provided with adequate moisture.

2. Leaf leachates are toxic material are removed from leaves by rain or fog drip. Significant in areas with heavy fog or strongly seasonal rainfall (e.g. Eucalyptus globulus suppressing annual grasses in CA).

3. Root exudates released to the soil.
   a) Living roots can release toxic compounds that inhibit nearby plants, e.g. sorghum, black walnut (C-S Tang apparatus for collecting root exudates.)
   b) microorganisms can colonize the root rhizosphere of plants and secret toxins and live off of carbohydrates from the plant. (JD work with actinomycetes and reniform nematode control with Rhodes grass and Sun hemp.)
4. Decay of plant materials and the release of allelopathic compounds.

   a) **Toxins present in plant tissue can be leached directly by rainfall, e.g. sorghum, oats, wheat and sunflower.**

   b) **Active inhibitors can be released during decomposition.**

      (1) Microorganisms can use plant tissue as substrate and release toxins as secondary metabolites or antibiotics. *Penicillium urticae* lived on wheat stubble and released a potent inhibitor called patulin, toxic to corn.

      (2) Microorganism can convert a non-toxic plant component and change it into a very toxic one (e.g. amygdalin found in peach bark, amygdalin applied directly to peach trees no effect when applied to trees in sand with nutrient solution, with emulsin which digests amygdalin to benzaldehyde and hydrogen cyanide, trees killed in 30-40 days.) Problem arose when people tried to replant peach trees in same hole after old tree died. (over head of allelopathic compounds)

C. **THE ROLE OF ALLELOPATHY IN NATURAL ECOSYSTEMS.**

1. Stabilization of disturbed environments:

   a) **plants grow and stabilized disturbed soil environments to prevent further degradation of the soil and loss of nutrients**

      (1) Types of disturbances

         (a) natural: fire, landslides, erosion from rivers and floods

         (b) man made: plowing, clear-cut forestry, mining, warfare, fire, etc.

   b) **Plants functions:**

      (1) to prevent soil movement by surface washing with roots

      (2) reduce lateral soil movement by braking the fall of raindrops

      (3) improve soil porosity by providing organic matter which aggregates soil

      (4) retains nutrients in plant materials at the soil surface and inhibits soil microorganism that allow for leaching of nitrogen
2. Site evolution of plant species from a disturbed to stable ecosystem

   a) Without human intervention, weeds and shrubs and eventually trees or other perennial species will occupy the land.

   b) The appearance of different species starting with bare ground through climax vegetation is called succession

      (1) Climax vegetation = stable plant community until major disturbance, either natural or man-made.

      (2) Plant species and their appearance in a specific succession represent a society of plants that exist within a time frame to serve as specialist in the rebuilding of a stable plant/soil environment.

         (a) Weeds are the pioneers that quickly cover the soil and extract nutrients, which might be leached away. Nutrients bound to plant tissues are less likely to be removed from the environment.

         (b) Perennial grasses follow to produce large amount of organic material for support of soil microorganisms. These microorganisms convert plant parts to stable organic molecules which improve the soil's ability to retain nutrients and moisture.

         (c) Finally woody plant species invade and can represent the last members of the succession, until another disturbance occurs. Trees make use of deep roots to bring nutrients to the surface and provide a substantial buffer to changing climatic conditions. Plants make use of chemicals to maximize their effectiveness in a given stage of succession. Toxins from leaves and living roots and decaying plant tissue insure the proper successor, i.e. one that can tolerate the toxicity.

         (d) Defensive chemicals work against insects and diseases to allow for continued growth.

         (e) Associations with beneficial soil microorganisms insure efficient uptake of nutrient (mycorrhizal fungi) and prevention of N leaching (pine tree needles contain chemicals that suppress denitrifying bacteria, N maintained in a stable form), resistance to disease (via association with antibiotic producing organisms in the root zone).
D. INFLUENCES OF ALLELOPATHY IN CONTROLLED OR AGRICULTURAL ECOSYSTEMS

1. Modern crops have been selected by breeders for desirable agricultural characteristics, which have removed allelopathic properties.

   a) Rapid seed germination achieved by selecting lines with reduced seed coat inhibitors. Some germination inhibitors also act as antibiotics/fungicides.

   b) Increase production of edible parts, allelopathic compounds and all other secondary (defensive metabolites) require energy. Cultivated crops are developed for either high sugar content or larger heads of grain or bigger storage roots. Human selection pressure has been against natural defensive mechanisms (i.e. defensive chemicals).

   c) Other numerous selections for desirable plant virtues must of necessity reduced levels of bitterness or other chemical which wild forms make use of for defense.

2. Using allelopathy in agriculture.

   a) In new forests or in reforestation make use of allelopathy by planting a mix of species that speed up succession thus preparing the soil for long term support of tree crops.

   b) For nematode and soilborn disease control use rotations with ground covers shown to strongly reduce these problems. Rhodes grass useful for reniform nematodes and soybeans for potato scab.

(1) New methods of controlling nematodes and other soil diseases involves the use of green manure/cover crops and solarization

   (a) Cover crops that contain known chemical compounds are planted and grown for 1-2 months. The green material is mowed and raked into rows then tilled in and covered with clear plastic tarps. The plastic tarp warms the soil and helps to disperse toxic vapors that form during decomposition.

   c) Weed control can be achieved by combining no-tillage-farming techniques with ground cover containing weed-suppressing toxins. Decaying residues can provide a significant amount of organic toxins to suppress weeds; sorghum can be used in this way.