ALLELOPATHY

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Allelopathic effects of weeds: Concept, allelopathic effects of weeds on crop and vice-versa. Some examples of weeds having allelopathic effects.

Concept

The phenomenon of one plant having detrimental effect on another through the production and exertion of toxic chemical compounds is called allelopathy. Allelopathy is the indirect harmful effect through exertion of chemical substances.

Allelopathy is existent in the natural ecosystem and it occurs widely in the natural plant communities. Allelopathy is possibly a significant factor in maintaining the present balance among the various plant communities. Allelopathic substance was first detected by Davis (1928) in black walnut tree (*Juglans nigra*) whose foliar leachate containing Juglone was found to damage germination and seedling growth of crops beneath the tree.

Allelopathic Chemicals

- Phenolic acid
- Coumarins – block mitosis in onion by forming multinucleate cells
- Terpinoids
- Flavinoids
- Scopulatens – inhibits photosynthesis without significant effect on respiration

Ways of releasing allelochemicals

Allelopathic chemicals are released from the plants as:

- Vapour – from root and leaf (through stomata)
- Foliar leachate
- Root exudate
- Breakdown/ decomposition product of dead plant parts
- Seed extract

- **Volatilization**. Allelopathic trees release a chemical in a gas form through small openings in their leaves. Other plants absorb the toxic chemical and die.
- **Leaching**. All plants lose leaves. Some plants store protective chemicals in the leaves they drop. When the leaves fall to the ground, they decompose and give off chemicals that protect the plant. Fall foliage tends to release more potent allelochemicals than fresh, spring foliage. Water-soluble phytotoxins may be leached from roots or aboveground plant parts or they may be actively exuded from living roots. Rye and quackgrass release allelopathic chemicals from rhizomes or cut leaves.
- **Exudation**. Some plants release defensive chemicals into the soil through their roots. The released chemicals are absorbed by the roots of nearby trees. Exuding compounds are selectively toxic to other plants. Exudates are usually various phenolic compounds (e.g., coumarins) that tend to inhibit development.

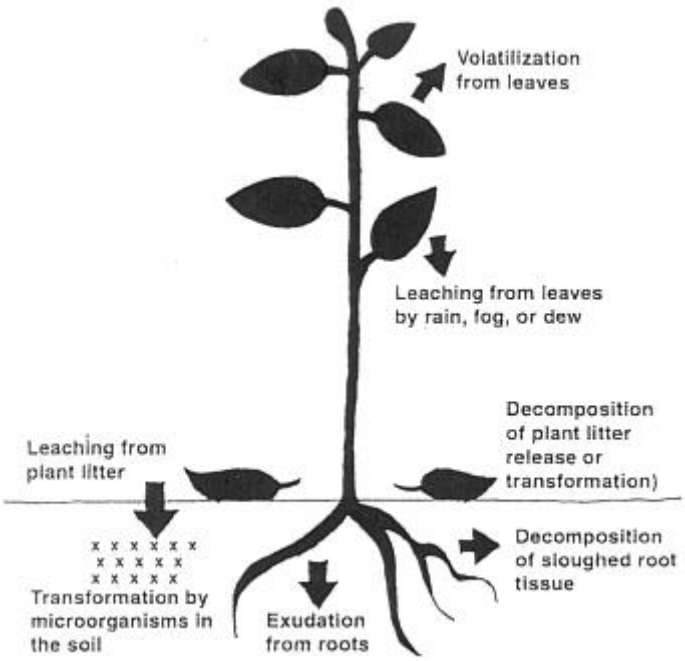


Figure: Sources of allelopathy

Allelopathic chemicals from plants may be released from living leaves as volatiles or leachates or from roots through exudation or sloughing off of dead tissues. They also may be leached from leaf liter on the soil surface.

Types of allelopathy

1. **Weed on Crop:**
   - *Agropyron repens* (Quack grass) is an important weed of field crops, which causes serious decreases in yield of maize and potato. It interferes with uptake of manures, particularly nitrogen and potassium by maize. Ethylene is generated in quack grass rhizomes due to microbial activity in soil, which is responsible for allelopathic effects of the weed resulting in decrease uptake of mineral by associated crops.
   - *Avena fatua* (Wild oat) is a serious weed of winter annuals like wheat, barley and oats. Wild oat residues inhibit germination of certain herbaceous species in shrubs stand due to an allelopathic mechanism. Growth of leaves and roots of wheat is significantly reduces by root exudate of wild oat.
   - *Cynodon dactylon* (Bermuda grass) found on cultivated lands. Decayed Bermuda grass residues remain in the field inhibits seed germination, root and top growth of barley due to allelopathic effect.
   - *Cyperus esculentus* (Yellow Nut sedge) is a perennial nut sedge infesting grain crops, soybean, orchards etc. It inhibits root and shoot growth of maize and soybean. The effect of soybean is due to the allelopathic compounds- vanillic acid, hydroxybenzoic acid in the yellow nut sedge extract.
   - *Sorghum halepense* (Johnson grass) is a persistent perennial weed in sugarcane, maize, soybean etc. Root exudates and decaying residues of Johnson grass can inhibit both root and shoot growth.
   - *Setaria viridis* (Giant foxtail) – Yield reduction in corn is due to the inhibitory effect of exudates of mature giant foxtail roots and leachates of dead roots.
   - *Impereta cylindrica* (Cogon grass) inhibits the growth tomato and cucumber.
   - Field bindweed, Canada Thistle- release root exudates that affect seedling growth of many crops e.g. cabbage, carrot, tomato, radish etc.

Weed on Weed

- *Impereta cylindrica* (Cogon grass)– inhibits the emergence and growth of an annual broadleaf weed i.e. *Borreria hispada* (Button weed) by exudating inhibitory substances through rhizomes.
- *Sorghum halepense* (Johnson grass) – living and decaying rhizomes and leaves inhibit the growth of *Setaria viridis* (Giant foxtail), *Digitaria sanguinalis* (Large crabgrass), and *Amaranthus spinosus* (Spiny amaranth).

Crop on Weed

- *Coffea arabica* (Coffee) release 1,3,7-trimethylxanthin which inhibts germination of *Amaranthus spinosus* (Spiny amaranth).
- *Zea mays* (Maize) root extracts increase catalase and peroxidase activity of the weeds which inhibit their growth.
- Oat, pea, wheat suppress the growth of *Chenopodium album* (Lamsquarter).
- Recently some rice genotypes have already been identified which have allelopathic effects on weeds.
- Allelopathic effect of crops and weeds on other weeds may be applied to develop natural herbicides.

Factors affecting Allelopathic effect

Allelopathic effects might also depend on a number of other factors that might be important in any given situation:

- ***Varieties*:** there can be a great deal of difference in the strength of allelopathic effects between different crop varieties
- ***Specificity*:** there is a significant degree of specificity in allelopathic effects. Thus, a crop which is strongly allelopathic against one weed may show little or no effect against another
- ***Autotoxicity*:** allelopathic chemicals may not only suppress the growth of other plant species, they can also suppress the germination or growth of seeds and plants of the same species. Lucerne is particularly well known for this and has been well researched. The toxic effect of wheat straw on following wheat crops is also well known
- ***Crop on crop effects*:** residues from allelopathic crops can hinder germination and growth of following crops as well as weeds. A sufficient gap must be left before the following crop is sown. Larger seeded crops are effected less and transplants are not affected
- ***Environmental factors*:** several factors impact on the strength of the allelopathic effect. These include pests and disease and especially soil fertility. Low fertility increases the production of allelochemicals. After incorporation the alleopathic effect declines fastest in warm wet conditions and slowest in cold wet conditions.

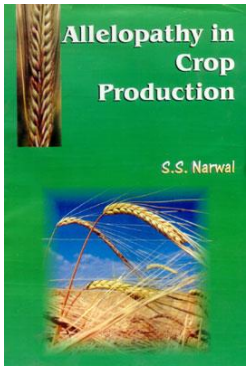
Stimulatory Effects

Plants also produce certain chemical compounds, which have stimulatory effects on the germination and growth of other plant species. Corn roots contain a complex of stimulatory substances. The water-soluble component of these substances promote the germination of *Orobanche minor* (parasitic weed), and the ethyl soluble fraction stimulate the germination of *Striga hermonthica*, (another parasitic weed). Sorghum root produces Kinetin and certain other aminopurines, which stimulate the germination of witch weed (*Striga asiatica*), a root parasite in Sorghum.

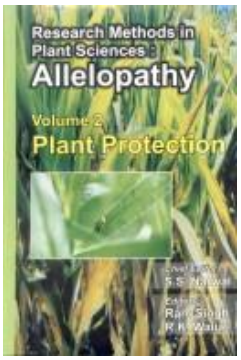
Allelopathic effect at a glance

Weeds	Crops	Cause/source	Effect
Agropyron repens (Quack grass)	Maize, potato	Ethylene produced by the activity of microorganism on rhizomes	Decrease uptake of manures (N,K) followed by yield reduction
Avena fatua (Wild oat)	Wheat, barley, oat	Root exudates	Growth of leaves and roots of wheat
Cynodon dactylon (Bermuda grass)	Barley	Decayed grass residues	Seed germination, root and top growth
Cyperus esculentus (Yellow Nut sedge)	Grain crops, soybean, orchard	Vanillic acid, Hydrobenzoic acid in sedge extract	Root and shoot growth of maize and soybean
Sorghum halepense (Johnson grass)	Sugarcane, maize, soybean	Root exudates and decaying residues	Root and shoot growth
Setaria viridis (Giant foxtail)	Maize	Roots and leachates of dead roots	Yield reduction
Impereta cylindrica (Cogon grass)	Tomato and cucumber	Root extracts	Inhibit growth
Field bindweed, Canada Thistle	Cabbage, carrot, tomato etc.	Root exudates	Seedling growth
Weeds	**Weeds**	**Cause/source**	**Effect**
Impereta cylindrica (Cogon grass)	*Borreria hispada* (Button weed)	Exudates of inhibitory substances through rhizomes	Inhibits the emergence and growth
Sorghum halepense (Johnson grass)	*Setaria viridis* (Giant foxtail), *D. sanguinalis* (Large crabgrass)	Living and decaying rhizomes and leaves	Inhibit growth
Crops	**Weeds**	**Cause/source**	**Effect**
Coffea arabica (Coffee)	*Amaranthus spinosus* (Spiny amaranth)	1,3,7-trimethylxanthin	Inhibit germination
Zea mays (Maize)	Associated weeds	Increased Catalase and Peroxidase activity by root extract	Inhibit growth
Oat, pea, wheat	*Chenopodium album* (Lamsquarter)	Root exudates	Suppress growth

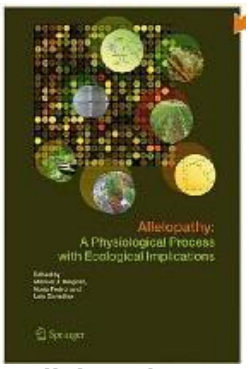
Suggested Books:



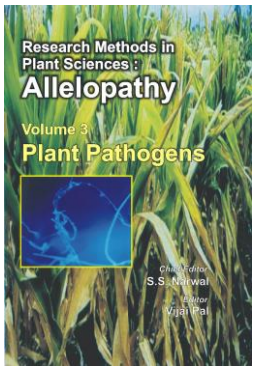
Allelopathy in Crop Production
By Narwal,S.S.



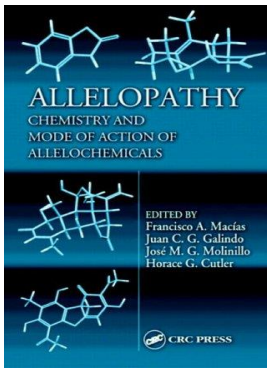
Research Methods in Plant Sciences : Allelopathy : Plant Protection,
By Ram Singh and R.K. W



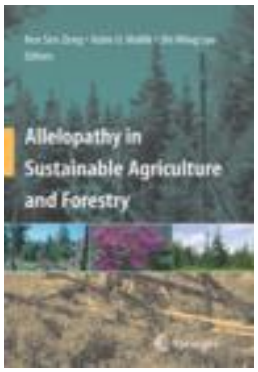
Allelopathy: A Physiological Process with Ecological Implications
By Manuel J. Reigosa, Nuria Pedrol and Luís González



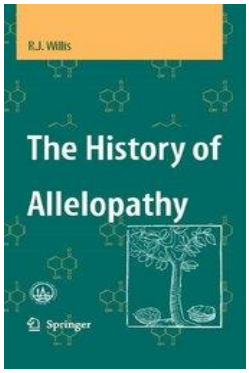
Research Methods in Plant Science : Allelopathy (Plant Pathogen)
By Narwal, S.S.



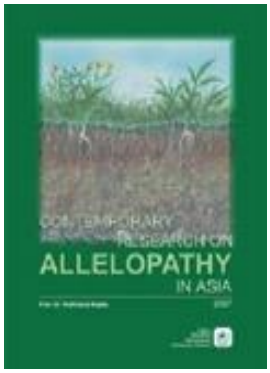
Allelopathy: Chemistry and Mode of Action of Allelochemicals
By Francisco A. Macias, Juan C. G. Galindo, Jose M. G. Molinillo and Horace G. Cutler



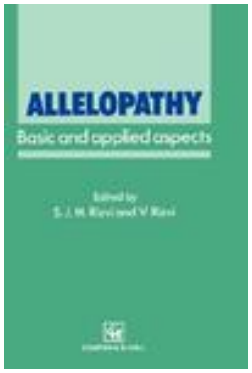
Allelopathy in Sustainable Agriculture and Forestry
By Zeng Ren Sen, Mallik Azim U. and Luo Shi Ming



The History of Allelopathy
By R.J. Wills



Contemporary Research on Allelopathy in Asia
By Rukhsana Bajwa



Allelopathy: Basic And Applied Aspects
By S. J. Rizvi and V. Rizvi