

Allelopathic Research in Agriculture: Theory And Practice

Kon-Kuk University
Ill-Min Chung

Allelopathy (interspecific effect) is called any direct or indirect harmful and beneficial effect by one plant including microorganisms on another through the production of various chemical compounds that release into the environment. Autotoxicity is an intraspecific form of allelopathy. Commonly accepted allelochemicals (secondary plant compounds) include terpenoids and steroids, phenolics and their derivatives, coumarins, flavonoids, tannins, alkaloids and cyanohydrins. These toxic compounds are released by volatilization, exudation from roots, leaching by rain, dew, fog and decomposition of residue. The effects of secondary substances released by these mechanism can be long-lasting (long term) or quite transitory (short term) and can ultimately affect practices including fertility, seeding, and crop rotation.

Biological-ecological and chemical-analytical phase in the investigation of a suspected allelopathic phenomenon are needed. The proper methodology to demonstrate clearly and unambiguously an allelopathic mechanism of plant interference has not yet been developed. The underlying problem is that it is difficult to determine nature of the plant interaction and separate competitive components of that interaction from other forms of interference. Additive design and replacement series can be used in field phase.

Allelopathic regulation of plant growth and development depends upon the concentration, species-specific, combination of substances, soil and environmental factors (light quality, intensity, duration, temperature), interaction with stresses. The source of allelochemicals in agricultural fields may be the weeds, crops, microorganisms. Allelochemicals representing numerous chemicals groups have been isolated from over 30 families of higher plants. Worldwide, about 90 weed species have shown allelopathic attributes.

To minimize the negative effects of allelopathy on crop growth and yield and to utilize allelopathic mechanisms as additional pest control or crop growth regulation strategies are two major challenges to agricultural researchers. Yields may be affected by (1) the inhibitory or stimulatory effect of a crop on the subsequent crop (2) the capacity of crop plants to inhibit weeds (3) production losses due to allelopathic weeds. Allelopathic interference with germination or growth of a crop can occur from direct effects on metabolism, or indirectly through effects on nitrogen fixation and other microorganism activity. Many physiological processes are changed by allelochemicals, but it is difficult to determine the primary mechanism involved for a specific compound.

Both avoidance and application strategies allelopathic interaction is now being employed to utilize allelochemicals for improving crop production over weeds. Techniques may take the form of (1) identifying and synthesizing new compounds that appear as secondary metabolic compounds in allelopathic plants as natural herbicide (2) using traditional plant breeding or genetic engineering methods in transferring allelopathic traits crops (cucumber, oat, sunflower, soybean, sorghum, peanut) into commercial crop cultivars (3) using allelopathic plants in crop rotation, companion plantings (beet, lupine, corn, wheat, oat, pea, buckwheat, hairy vetch, pearl millet, barley, rye, cucumber) and smother crops (4) the use of phytotoxic mulches and cover crops like wheat, barley, oat, rye, grain sorghum, sudangrass, winter legumes, in conservation and no-tillage crop production (5) using allelochemicals or derivatives to stimulate weed seed germination and reduce the soil weed seed load. Allelopathic characteristics are more likely to occur in crop predecessors or wild types that have evolved in the presence of other interfering species.

Allelopathy research potentiality offers unlimited opportunities to solve practical agricultural problems like weeds control, environmental contamination risks through the use of allelopathic plants or their isolated products and to contribute fundamental knowledge regarding the chemistry and biology of interspecific or intraspecific relationships.