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Allelopathy – A Biological Phenomenon and Its Effects in Agriculture

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Allelopathy is a biological phenomenon by which an organism produces one or more biochemicals that influence the germination, growth, survival, and reproduction of other organisms. These biochemicals are known as **allelochemicals** and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms and the community.Allelopathy is often used narrowly to describe chemically-mediated competition between plants, however, it is sometimes defined more broadly as chemically-mediated competition between any type of organisms. Allelochemicals are a subset of secondary metabolites, which are not directly required for metabolism (i.e. growth, development and reproduction) of the allelopathic organism.

Allelopathic interactions are an important factor in determining species distribution and abundance within plant communities, and are also thought to be important in the success of many invasive plants. For specific examples, see black walnut (*Juglans nigra)*, tree of heaven (*Ailanthus altissima*), black crowberry (*Empetrum nigrum*), spotted knapweed (*Centaurea stoebe*), garlic mustard (*Alliaria petiolata*), *Casuarina/Allocasuarina spp.*, and nutsedge.

It can often be difficult in practice to distinguish allelopathy from resource competition. While the former is caused by the addition of a harmful chemical agent to the environment, the latter is caused by the removal of essential nutrients (or water). Often, both mechanisms can act simultaneously. Moreover, some allelochemicals may function by reducing nutrient availability. Further confounding the issue, the production of allelochemicals can itself be affected by environmental factors such as nutrient availability, temperature and pH. Today, most ecologists recognize the existence of allelopathy, however many particular cases remain controversial.

Allelopathy Effects/Environmental Impact

Allelopathy is a form of chemical competition. The allelopathic plant is competing through "interference" chemicals. Competition by definition takes one of two forms exploitation or interference. When organisms compete with one another, they create the potential for resource limitations and possible extinction. Allelopathic plants prevent other plants from using the available resources and thus influence the evolution and distribution of different species. One might say that allelopathic plants control the environments in which they live.

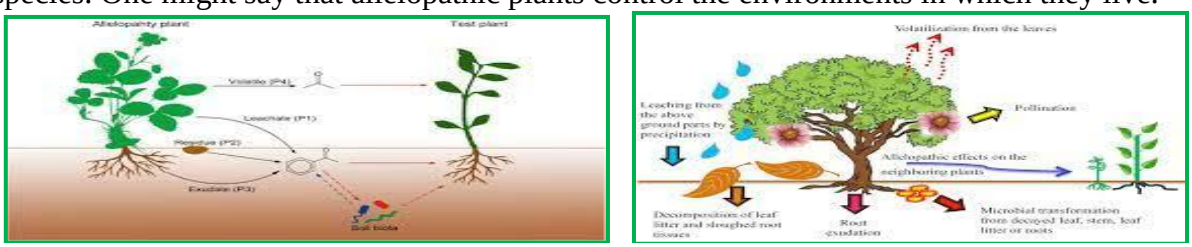

Figure: Plant Allelopathy in Agriculture

Allelopathic plants

Though a considerable number of plants in nature show allelopathic behavior. Allelopathy is not a common phenomenon for all plant species. Some plants and trees that are well known as allelopathic are Black Walnut (*Juglans nigra*), Ailanthus or Tree Of Heaven (Ailanthus altissima), Fragrant Sumac (*Rhus aromaticus*), Rice (*Oryza sativa*), Pea (*Pisum sativum*), sorghum, etc.

Black walnut is an expert allelopathic plant that contains allelopathic properties within its leaves, buds, roots, and nut hulls. It is also known to secrete a substance into the soil called juglone, a respiratory inhibitor to some plants. Though most of the allelopathic plants store their chemical weapon, allelochemicals, within their leaves, allelopathic properties can be stored within several organs of the allelopathic plants. The allelopathic characters can be found in the roots, barks, flowers, fruits, seeds, pollen, foliage, etc., of the allelopathic plants.

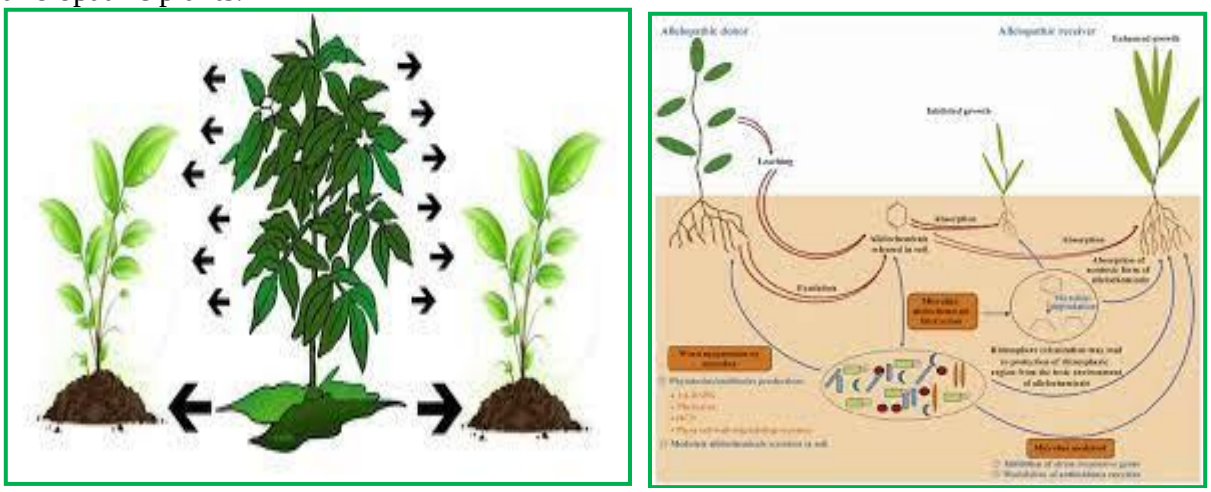

Figure: Allelopathy on plant performance

Advantages of Allelopathy

Allelopathic plants can be introduced in agroecosystems to get some advantages from that

1. Allelopathy can be used for beneficial purposes through using allelochemicals as natural herbicides or pesticides. Various allelochemicals classes, including alkaloids, flavonoids, cyanogenic compounds, cinnamic acid derivatives, benzoxazines, ethylene, and some other seed germination stimulants, can be isolated from various families of terrestrial and aquatic plants. These allelochemicals are readily or potentially phytotoxic to many unnecessary plants.
2. Using allelopathic plants in companion cropping may bring a great advantage to an agroecosystem. A selectively allelopathic plant can be used as a companion plant with a particular crop plant. The selectively allelopathic plant will suppress certain weeds and will not disturb the growth of the main crop. The introduction of several crop species such as corn, lupin, oats, beets, wheat, peas, millet, barley, rye, etc., in companion cropping has been proved effective in suppressing several weeds.
3. Some parasitic weeds produce seeds that germinate in response to chemical compounds released from their hosts. For instance, Striga, a parasitic plant to cereals, germinates in response to pbenzoquinone compound released from its natural host sorghum. Ethylene is also effective in stimulating Stirga to germinate. Thus, ethylene can be applied to make Stirga germinate in the absence of a host. Using allelochemicals to stimulate the suicidal germination of weed seeds reduces the number of dormant seeds in the soil.
4. The allelopathic characteristics of wild plants can be transferred into commercial crops to boost up their allelopathic traits for weed suppression.

5. Selectively toxic plant residues can be appropriately managed to control weeds efficiently. Using allelopathic crops in crop rotation, covering cropping with smother crops, using phytotoxic mulches, etc., can be examples of some good allelopathic residue management practices.

Common plants with allelopathic properties can be seen and include: English laurel (Prunus laurocerasus) Bearberry (Arctostaphylos uva-ursi) Sumac (Rhus) Rhododendron Elderberry (Sambucus) Forsythia Goldenrod (Solidago) Some types of fern Perennial rye Tall fescue Kentucky bluegrass Garlic Mustard Weed Allelopathic Trees Trees are great examples of allelopathy in plants. For instance, many trees use allelopathy to protect their space by using their roots to pull more water from the soil so other plants cannot thrive. Some use their allelochemicals to inhibit germination or impede the development of nearby plant life. Most allelopathic trees release these chemicals through their leaves, which are toxic once absorbed by other plants. Black walnut is a prime example of this. In addition to its leaves, black walnut trees store allelopathic properties within their buds, nut hulls, and roots. The chemical responsible for its toxicity, called Juglone, remains in the soil around the tree and is most potent at the drip line, though the roots can spread out well beyond this. Plants most susceptible to the black walnut's toxicity include nightshade plants (tomatoes, peppers, eggplants, potatoes), azaleas,pines,andbirchtrees.

Some examples of allelochemicals

Allelochemicals like **phenolics, steroids, saponins, terpenoids, alkaloids, and flavonoids** possessed by different tissues of several plants exhibit numerous antioxidant production of antioxidant behaviors and ultimately protect the plants from several deleterious pathogens.

Conclusion

Allelopathy can be utilized for suppressing weeds in field crops. Allelopathy has a pertinent significance for ecological, sustainable and integrated weed management systems.

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