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Q8

What is allelopathy? Discuss its role in major cropping systems of irrigated agriculture.

UPSC Civil Services Mains 2016 · GS III · 12 marks · Crops, Irrigation and Marketing

Major crops - cropping patterns in various parts of the country; different types of irrigation and irrigation systems; storage, transport and marketing of agricultural produce and issues and related constraints; e-technology in the aid of farmers.

Core demand of the question

- Define allelopathy
- **Discuss its role in major irrigated cropping systems:** weed control, residue management, rice-wheat, and intercropping
- Keep the science applied to Indian irrigated agriculture

Revision summary

Allelopathy is the chemical effect of one plant on another through leachates, exudates or decaying residues.

In irrigated rice-wheat it can suppress weeds such as barnyard grass and also cause residue **autotoxicity** if straw is mismanaged.

Sorghum, sunflower, mustard and some mulches are used for weed suppression in irrigated field crops.

Sugarcane, cotton and canal-side agroforestry also show allelopathic effects on ratoons and adjoining wheat.

It supports, but does not replace, integrated weed and residue management.

Introduction

Allelopathy is the effect of one plant on another through **chemicals released** from leaves, roots, litter or decomposing residues. The effect may suppress weeds or neighbour crops, or, less often, stimulate them. In **irrigated agriculture**, where rice, wheat, sugarcane and cotton repeat on the same land, allelopathy is a tool for **weed management and residue use**, and a risk when residues or intercrops poison the next stand.

Body

What allelopathy is

- Plants release **allelochemicals** (phenolics, terpenoids, alkaloids, glucosinolates) by leaching, root exudation, volatilisation or decay.
- Unlike simple shading or nutrient theft, the pathway is **chemical**. Laboratory bioassays must be checked in the field, because irrigation water can dilute or move the compounds.
- **Autotoxicity** is a special case: a crop's own residues harm the next sowing of the same species, seen in some rice, lucerne and sugarcane systems.

Role in major irrigated systems

- **Rice-wheat on the Indo-Gangetic plains:** rice straw and wheat stubble contain phenolics. Poorly managed residues can delay the next crop's roots; well-timed incorporation or microbial breakdown can reduce that harm. Some rice cultivars show weed-suppressive allelopathy against **Echinochloa** (barnyard grass), which matters as herbicide resistance rises.
- **Weed control:** sunflower, sorghum, mustard, eucalyptus leaf mulch and some rice lines release compounds that suppress *Phalaris*, *Avena* and broad-leaf weeds. This can cut herbicide load in irrigated wheat and maize if density and timing are right.
- **Intercropping and trap systems:** mustard, sorghum or cowpea allelopathy can protect a main irrigated crop from weeds; the companion must be chosen so it does not also stunt the main crop.
- **Sugarcane and cotton:** residue and ratoon allelopathy, plus intercropped pulses or sunnhemp, can affect sprouting and early weed flush. Irrigation keeps soils moist, which can either speed breakdown of **allelochemicals** or spread them in the root zone.
- **Green manures and oilseed cakes:** mustard cake and some green-manure residues combine nutrient supply with suppression of soil-borne pests and weeds - a chemical-biological mix, not magic.
- **Agroforestry on canal commands:** poplar and eucalyptus belts can allelopathically affect adjoining wheat if leaf litter and roots are unmanaged; spacing and leaf removal are the farm response.

Practical caution

- Allelopathy is **not a full substitute** for water, nutrients and integrated weed management. It is one layer with crop rotation, stale seedbeds and judicious herbicides.
- Breeding **weed-suppressive cultivars** and using residue mulch under **conservation agriculture** are the scalable research paths for irrigated India.

Flow diagram

Donor plant -> Allelochemicals
 Allelochemicals -> Weed suppression
 Allelochemicals -> Crop injury autotoxicity
 Rice wheat sugarcane cotton -> Allelochemicals
 Weed suppression -> Lower herbicide load
 Crop injury autotoxicity -> Residue timing rotation

Conclusion

Allelopathy is chemical interference among plants. In irrigated rice-wheat, sugarcane, cotton and intercrops it can suppress weeds and also injure the next crop if residues are mishandled. Used with rotation, mulch and cultivar choice, it is a low-cost support to water-and-chemical-intensive irrigated systems.

Facts & figures

Allelochemicals

Secondary plant compounds (phenolics, terpenoids, alkaloids) that affect germination or growth of other plants.

Autotoxicity

A crop's residues harm the next sowing of the same crop; reported in some rice, lucerne and sugarcane stands.

Echinochloa

Barnyard grass, a major irrigated-rice weed; some rice genotypes show allelopathic suppression of it.

Rice-wheat system

Dominant irrigated rotation of the Indo-Gangetic plains, where residue chemistry affects the succeeding crop.

Conservation agriculture

Minimum tillage, residue mulch and rotation; allelopathy is one reason residue management must be designed, not dumped.

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