ALLELOPATHY: A WEED MANAGEMENT APPROACH IN FRUIT CULTURE

NARAYAN LAL, A K BISWAS, A K PATRA

ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh
*Corresponding author, E-mail: narayanlal.lal7@gmail.com

Fruits play important role in human diet as they are cheap source of dietary fibres, vitamins and minerals. However, the tremendous use of chemicals in orchards in order to manage pests, disease, and weeds add harmful chemicals to this food source. Though integrated pest management approaches and planting of pest and diseases resistant cultivars have reduced use of fungicides and insecticides in orchards. The use of herbicides continues as the major weed management tool in many Indian orchards due to labour scarcity. Increased use of herbicides also lead to the development of herbicide resistance in targeted weeds in the long run and increase the growth of non-targeted weed population. The search for alternative methods of weed management by farmers and agriculturist to minimize or avoid the frequent uses of herbicides increases the importance of natural weed management concept like 'Allelopathy'. Allelopathy refers to the direct or indirect positive or negative effect of one plant(s) on other plant(s) through the release of some compounds called allelochemicals. Weed control making use of the allelopathy concept not only helps to reduce the negative impact of chemicals on environment but also reduces the production costs.

ALLELOPATHIC POTENTIAL OF FRUIT CROP IN WEED MANAGEMENT

Fruit crops are perennial in nature and they produce huge amount of biomass above as well as below ground level. Leaves are most important sources of allelochemicals contribute lots. Shrinking of arable land and higher benefit through horticultural crops invited fruit based multiple cropping systems in modern agriculture. Allelochemicals released by fruit crops not only influence the growth and development of plants for better crop yield but also suppress growth of some other plants (weeds) in the plant basins. For example fruit trees like litchi (*Litchi chinensis) guava (Psidium guajava) lemon (Citrus limon) etc.* rarely permit growth of other plant species under its canopy in natural environment (Figure 1).

Figure 1. Natural weed management through allelopathic effect under the canopy of (a) citrus and (b) guava plants (Location: Instructional farm of ICAR-Indian Institute of Soil Science, Bhopal)

RELEASE OF ALLELOCHEMICALS

Fruit crops produce allelochemicals in different plant parts like leaves, stem and roots. These chemicals generate an effect on the target plants when they release to soil from the donor plants. Water soluble allelochemicals from aerial parts reach soil through rain water, mist, dew drops, fog or drip. Generally, allelochemical are released to soil as (1) runoff and leachate from aerial parts; (2) volatile phytotoxic compounds from the green plant parts; (3) phytotoxic compounds from decomposing plant material; (4) phytotoxic compounds from plant roots.

MODE OF ACTION

There are two types of allelopathy i.e. direct or primary allelopathy and indirect allelopathy or mediated allelopathy. If a plant or a microorganism inhibits or stimulate the growth of another plant or microorganism without the involvement of a mediator, it is called direct allelopathy whereas, an intermediate organism is involved in releasing the allelochemicals to other plants in indirect allelopathy.

Modes of action of allelochemicals are also direct or indirect. Effects through altering soil properties, nutritional status, soil microbial population or microbial activities, soil organisms and nematodes etc. are categorised as indirect action. In direct action, allelochemicals disturb the biochemical or physiological activities of plants. Alleochemicals like phenolic acid can alter rate of mineral uptake in plants and some other chemicals inhibit activities of enzymes like IAA oxidase that regulate activities of phytohormones like Indole Acetic Acid (IAA) and Gibberellic Acid (GA).

WEED MANAGEMENT USING ALLELOCHEMICALS

Timely removal of weeds is one of the most important cultural practices to get sufficient nutrients, water, sunlight, and space for crop plants to grow healthy without any competition from weeds. Weeding also help in controlling many pest and diseases incidences. But, many times labour scarcity prevents farmers from keeping their orchards weed free. In these situations allelochemicals can be used effectively for weed management with less labour input. Use of leaf extract of mango, litchi, guava etc. as herbicide suppresses weed growth (Table 2). Also, tropical almond *(Terminalia catappa*) controls the growth of weeds like *Euphorbia heterophylla* and *Commelina bengalensis*. In addition, planting of turmeric as intercrop in orchards also reduces weed growth through allelopathic effect (Figure 2).

Table 1. Release of allelochemicals by fruit crops and weeds affected

Crops	Plant Parts	Allelochemicals	Target Weeds
Mango	Leaf	Mangiferin (1,3,6,7-tetra hydroxyl 2-C-B-glucopyranosylxanthone)	Purple Nutsedge Canary grass
Litchi	Leaf	Epicatechin, ProcyanidinA2, Kaempferol-3-0-galactose and 4-ydroxybenzaldehyde	Spanish needle Indian goosegrass Duckweed
Passion fruit	Leaf, stem, root	Kavin,Yagonin, Dihydromethysticin, Coumarin	Barnyard grass Monochoria
Ber		Zizynummin, Dammarane, Saponin	
Guava	Leaf		Congress grass
Walnut	Leaf	20% methanol, ethyl acetate and hexane n-Hexadecanoic acid, 9,12-octadecadienoic acid (Z,Z), 8-octadecenoic acid and 5-hydroxy-1,4-napthaquinone	Henbit Creeping thistle Field poppy

(Source: Venkateshwarlu *et al.,* 2001; Islam *et al.,* 2013; Khanh *et al.,* 2008; Saroj*et al.,* 2000; Cui *et al.,* 2011)

Fig 3. Intercropping of turmeric in litchi orchard to suppress weed

ALLELOPATHIC EFFECT AS WEED MANAGEMENT TOOL: LIMITATIONS

Researchers across the world who investigate more about the allelopathic use of plants in weed control revealed a number of benefits as well as limitations in using the concept of allelopathy as a weed management tool. Some of the plant itself that produces allelochemicals and the environmental conditions limit the use of allelopathic effect in effectively controlling weed growth. Because, the production, release and phytotoxicity of allelochemicals are influenced by various abiotic and biotic factors such as plant age, atmospheric temperature, sunlight, soil conditions, microflora, nutritional status, herbicide treatments etc. and plants may not have same allelopathic in different locations. Moreover, physical, chemical, and biological properties of soil influence on the activity of allelochemicals especially when they undergo transformation in soil. Once allelochemicals reach soil, microbes may toxify or detoxify them.

Researchers also explain that some allelochemicals are carcinogenic and toxic even to human beings. In fact, it is identified that some allelopathic agents released by plants could be active only under hot and dry climate and work as monoterpenes in vapour phase. Also, these chemicals adversely affect the growth of some plants grown under the plant that release allelochemicals.

Another factor that strongly influences the allelopathic potentiality of plant is the amount of nutrients available to the plant and the efficiency of the plant to utilize the nutrient. Autotoxic effect is also reported as another problem in the allelopathic mechanism where allelochemicals affect growth of the donor plant itself.

CONCLUSION

Allelochemicals released from different parts of fruit trees effectively suppress the growth of some nearby plants selectively. As fruit crops generate huge amount of residues in the form of leaves and twigs, using them as mulch in the tree basins is an economical way of controlling the growth of some weeds. Moreover, it is the most easily adoptable environment friendly weed management approach.

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