International Journal of Biology Research
www.biologyjournal.in
ISSN: 2455-6548
Received: 06-08-2022, Accepted: 22-08-2022, Published: 08-09-2022
Volume 7, Issue 3, 2022, Page No. 65-69

Allelopathy: Plant growth and weed management

Bhoomi Shah[1], Karishma Prajapati[1*], Archana Parmar[1], Ruby Patel[2]
[1] Research Scholar, M. N. College, Visnagar, Gujarat, India
[2] Assistant Professor, M. N. College, Visnagar, Gujarat, India

Abstract
Allelopathy is transfer of chemicals from one plant to another. Allelopathy is a larger area of ecological and physiological processes. According to modern research, depending on different concentrations, allelochemicals have positive or negative effects on plants. Allelochemicals are also known as secondary metabolites, compounds like phenol, alkaloids, steroids etc. Allopathic studies are performed to find out the effects of allelochemicals on seeds to promote or inhibit seed germination. Allelochemicals are also effective herbicides, fungicides, insecticides, and plant growth regulators that are environmentally friendly. Despite the fact that allelochemicals have been used as environmentally friendly herbicides for decades, natural herbicides made from allelochemicals are extremely rare. Herbicides made from natural products have been the subject of numerous studies.

Keywords: allelopathy, allelochemicals, weeds, seed germination

Introduction
Allelopathy is made up of two Greek words, “Allelon” means each other, and “pathos” means to suffer. Molisch used the term allelopathy in 1937 to describe all of the effects that emerge directly or indirectly from the transfer of biochemical components from one plant to another (Molisch, 1937) [37]. Allelopathy was defined as "any process involving secondary metabolites produced by plants, algae, bacteria, and fungus that influence biological system growth and development" (Ananya, 1997). In the 1970s, interest in allelopathy increased, and since the mid-1990s, it had become a prominent topic in botany, ecology, agronomy, soil science, horticulture, and other fields of study. Allelopathic interaction can be one of the most important variables influencing species distribution and abundance in plant communities, as well as invasive plant success (Chou, 1999; Mallik, 2003; Field, *et al.*, 2006; Inderjit, *et al.*, 2006; Zheng, *et al.*, 2015) [10, 35, 17, 50]. Allelopathy was one of several plant interactions that were influenced by many factors including nutrition, light, temperature, humidity, and others. (Sowin, *et al.*, 2020). Allelopathy may have both positive as well as negative impacts, according to modern research, depending on the concentration of allelochemicals and organisms involved (Rice, 1976; Gliessman,1978; Lodhi,1978, Ballester *et al.*, 1977; Fisher, *et al.*, 1978 and Lovett and Jackson,1980) [22, 33, 6, 19, 34]. Allelopathy is a complex event involving a large network of ecological and physiological processes that were interconnected (Scognamiglio *et al.*, 2013) [44].

Allelopathy and Allelochemicals
According to Whittaker and Feeny, (1971) [46] allelopathy was known to be mediated by allelochemicals or allelochemics and secondary metabolites. Allelochemicals are divided into five classes: phenylpropanes, acetogenins, terpenoids, steroids, and alkaloids. Allelopathy was known to be a relatively recent discipline of science (Lal & Audio, 1999) [30]. Identification of allelochemicals was necessary for the successful application of a plant's allelopathic qualities (Bhadoria, 2011) [8]. Allelopathy was a biological occurrence that affects nearby plants or was observed in agriculture through chemical substances produced (Hussain, 2020a) [24]. Rice, 1984; Ilori and Otusanya, 2013 [43, 25] noted that allelochemicals were mostly found in plant extracts and residues, but very few have been discovered in live plant exudates and volatile gases released from leaves. Ogbe *et al.*, 1994, Ilori and Otusanya, 2013 [51, 25] conclude that allelopathic substances have been found in several studies to inhibit plant growth at all stages from seed to maturity, including seed germination, seedling growth, leaf area, dry matter, fruit production, and biochemical components. Environmental factors affect the quantitative production of allelochemicals (Bezuidenhout, 2012) [7].

Seed Germination
In allelopathic bioassays, seed germination was a regularly utilized measure (Rice, 1984) [43]. Allelopathic interferences were used to create biotic stresses for germinating seedlings. Because the seed was a vital plant organ that was particularly sensitive to allelochemicals, its germination had been generally used as a bioassay in

allelopathic research (Aliotta, 2006) [3]. Seed germination data were useful since it was an important stage in the reproduction and cultivation of most crop species (Ishii-Iwamoto, 2006) [26]. On the other hand, there was no such information about the allelopathic effects of common weeds on tea, and no other researcher had attempted such a study. As a result, the research study was conducted to determine the effects of dominating weeds on seed germination and the early growth of tea seedlings (Ghosh *et al*., 2021) [20]. Allelochemicals affect seed germination by interrupting cellular processes rather than causing injury to organelles. Reserve mobilization, a procedure that normally occurs fast during the early stages of seed germination, appears to be delayed or reduced under allelopathic stress, according to all observations (Gniazdowska & Bogatek, 2005) [23].

Weed management

Weeds were undesired plants that do not provide farmers with economic production and were difficult to control (Mushtaq *et al.,* 2020) [39]. In agricultural production, the generally utilized weed control methods (herbicide treatment, machine weeding, and hand weeding) were effective However, these methods have major drawbacks, such as the evolution of herbicide resistance in weeds, the negative effects of herbicides on the ecosystem, human and animal health, the value of herbicides, soil structure losses, and the huge labor needs (Farooq *et al.,* 2011) [15]. Weeds continue to destroy crops, resulting in a significant reduction in production (Mushtaq & Siddiqui, 2018) [38]. Weeds, on the other side, have a huge impact on agricultural production, surpassing all other agricultural damage caused by insects, nematodes, disease, rodents, etc (Abouziena and Haggag, 2016) [1]. Also, careful control was needed to reduce the impact of weeds on agricultural production (Kaur *et al*., 2020) [28]. Allelopathy had major weed suppression effects and was one of the most widely used weed control procedures (Jabran & Farooq, 2013; Zeng, 2014) [27, 49]. According to (Bajwa *et al*., 2020) [5], water extracts of mature fine grains effectively regulate the population and biomass of a weed competitor, and fine grain water extract inhibits weed development and density and improves wheat production. The effects of allelochemicals from various plants, as well as the concentration of the extract on the target plants, were variable. Allelopathy was partly responsible for the decrease in the ability of rye, sorghum, and wheat, as per reports. Smothering crops could be utilized to control weeds including them in crop rotations, crop mixtures/intercropping systems, and breeding them for more allelopathic potential (Narwal & Tauro, 1994) [40]. Most of the other previous issues can be solved by using allelopathy to a diversity of weed management techniques. Combining multiple weed control methods was useful in decreasing the probability of weeds developing herbicide resistance. Furthermore, using a combination of decreased synthetic herbicide dose and allelopathic extracts can give control that was just as beneficial as using the standard herbicide dose (Farooq *et al.,* 2011) [15]. Additionally, in some fields, using a variety of weed management methods can provide long-term and effective weed control. Precision agriculture in various farms will also decrease the price by allowing farmers to use agriculture inputs based on the specific needs of the crop being developed. For example, procedures like selective fertilizer application and selective weed control guarantee that the treatment was applied correctly, preventing overuse or underuse. It had been created site-specific weed management utilizing autonomous spraying UAVs based on remote weed mapping (Laursen *et al*., 2016). Variable-rate fertilizer application systems have also been created based on field nutrient maps (Ferguson, *et al*., 2018). These methods would increase the efficiency of agricultural inputs, reduce environmental losses, and decrease greenhouse gas emissions (Finger, *et al*., 2019) [18].

Significance of allelopathy

The interaction of plants through chemical signals (allelopathy) had many possible agricultural applications (Nelson, 1996) [41]. Chemical pesticides have made significant contributions to world agricultural progress and protected uncountable people from hunger. Unfortunately, in recent years, excessive pesticide residues in agricultural products have developed from the overuse of chemical pesticides, producing major environmental issues and posing a serious threat to human health (yu-xia *et al.,* 2008) [48]. Biodegradable allelopathic plants release allelochemicals into the environment (Duke *et al*., 2002) [14]. Duke, *et al*., 2008 [13], focused on ancient medicinal plants and vegetable wastes in allelopathic experiments to isolate potential bioherbicides from plants, as they constitute a primary and yet underappreciated source of allelochemicals. Carried out a list of studies on significant mediterranean plants like rue, olive, squill, and lavender, which could be utilized as natural pesticides in sustainable agriculture. Li *et al*., 2021 [32] noted green pesticides and herbicides have been used to accommodate social demands. Allelopathy was a weed-control method that was used to reduce the effects of pollution on the environment. Allelopathy was a chemical procedure that helps a plant compete for a restricted range of resources (Gioria & Osborne, 2014) [21]. Allelopathic effects from decomposing plant residues, and a wide range of morphologies to biochemical activity, including various growth-regulating substances and synthetic pesticides, have been recorded (Akemo *et al*., 2000) [2]. Herbicides live in the environment, producing biomagnification. As a result, there was an urgent need to create biodegradable herbicides. Plant-derived herbicides will be less toxic and biodegradable (Babu *et al.,* 2014) [4]. Modern agriculture faces the difficult task of reducing environmental and health risks from chemical inputs, minimizing soil erosion, and maintaining a high level of production (Wyse, 1994) [47]. Plants and microorganisms produce thousands of secondary metabolites, including a unique chemical structure that could lead to novel herbicides, pesticides, growth promoters, or growth regulators (Keeler, & Tu, 1991) [29].

Future goals and Problems in allelopathy

Allelopathic plants have been suggested as a potential weed management alternative in the area of sustainable agriculture (Dahiya, *et al.,* 2017) [11]. The repressive effect of various allelochemicals in crops and trees was mostly due to blocked physiological and metabolic processes of a plant that had been utilized for weed management, both directly and indirectly (Cheng & Cheng, 2015; Farooq, *et al.*, 2011) [9, 15]. Allelochemical weed control was a viable alternative to produced herbicides with no negative side effects (Bhadoria, 2011) [8]. Non-pathogenic soil microorganism phytotoxins were less expected to be extremely selective, which could affect their agricultural application. Only a few of the microbial metabolites that could be beneficial have been recognized. Biodegradable, microbially produced pesticides to control insects, diseases, and weeds were expected to be economically available in the near future (Narwal, & Tauro, 1994) [40]. Cheng, & Cheng, (2015) [9] noted that whether evaluating if a plant had allelopathic potential or separating and detecting allelochemicals using organic solutions and aqueous extracts from plant tissues, researchers must be cautious. Endogenous levels of allelochemicals were utilized as indices of abiotic stress resistance in a recent study. Meanwhile, it had been discovered that exogenous application of allelochemicals increases the endogenous level of the receivers, resulting in increased growth and resistance to abiotic stresses (Maqbool *et al*., 2013) [36]; as a result, appropriate environmental conditions were required for allelopathic studies. A stressful atmosphere had been shown to stimulate the release of allelochemicals from allelopathic plants (de Albuquerque *et al.*, 2011) [12]. Cheng, & Cheng, (2015) [9] was define that allelochemical release characteristic and define the conditions required for allelochemical release by examining the dynamic release of allelochemicals under various stress conditions, thereby revealing the nature of allelochemicals.

Conclusion

Allelopathy has been employed in agriculture since ancient times, although its acknowledgment and application in modern agriculture are restricted. Allelopathy is used in the research of sustainable farming systems, as well as the regulation of weeds, diseases, and insects, the reduction of continuous cropping difficulties, and the development of allelopathic cultivars. Allelochemicals can also be used as eco-friendly herbicides, fungicides, insecticides, and plant growth regulators, making them extremely useful in sustainable agriculture. Despite the fact that allelochemicals have been utilized as ecologically beneficial herbicides for decades, there are extremely few natural herbicides produced from allelochemicals on the market. There are numerous investigations on natural-product herbicides. Allelopathy research has received a lot of interest recently, due to the growing importance of organic agriculture and environmental protection, and the physiological and ecological processes of allelopathy are rapidly being clarified. Furthermore, progress has been made in the understanding of the fundamental molecular pathways. Allelopathy clearly requires more research before it can be widely used in agricultural production around the world. Agricultural allelopathy has attracted the interest of scientists from all around the world. Field-based data has been connected to a search for allelochemicals in the most comprehensive weed surveys.

References

1. Abouziena HF, Haggag WM. Weed control in clean agriculture: a review1. Planta daninha,2016:34:377-392.
2. Akemo MC, Regnier EE, Bennett MA. Weed suppression in spring-sown rye (Secale cereale)–pea (*Pisum sativum*) cover crop mixes. Weed technology,2000:14(3):545-549.
3. Aliotta G, Cafiero G, Otero AM. Weed germination, seedling growth and their lesson for allelopathy in agriculture. In Allelopathy, 2006, 285-297.
4. Babu GP, Vinita H, Audiseshamma K, Paramageetham CH. Allelopathic effects of some weeds on germination and growth of *Vigna mungo* (L). Hepper. International Journal of Current Microbiology and Applied Sciences,2014:3(5):122-128.
5. Bajwa AA, Nawaz A, Farooq M. Allelopathic crop water extracts application improves the wheat productivity under low and high fertilizer inputs in a semi-arid environment. International Journal of Plant Production,2020:14(1):23-35.
6. Ballester A, Albo JM, Vieitez E. The allelopathic potential of *Erica scoparia* L. Oecologia,1977:30(1):55-61.
7. Bezuidenhout SR. Allelopathy as a possible cause for crop yield reductions. KZN Agri and Rural devt., 2012.
8. Bhadoria PBS. Allelopathy: a natural way towards weed management. Journal of Experimental Agriculture International, 2011, 7-20.
9. Cheng F, Cheng Z. Research progress on the use of plant allelopathy in agriculture and the physiological and ecological mechanisms of allelopathy. Frontiers in plant science,2015:6:1020.
10. Chou CH. Roles of allelopathy in plant biodiversity and sustainable agriculture. Critical Reviews in Plant Sciences,1999:18(5):609-636.
11. Dahiya S, Kumar S, Khedwal RS, Jakhar SR. Allelopathy for sustainable weed management. Journal of Pharmacognosy and Phytochemistry,2017:6:832-837.

12. de Albuquerque MB, dos Santos RC, Lima LM, de Albuquerque Melo Filho P, Nogueira RJMC, Da Câmara CAG, de Rezende Ramos A. Allelopathy, an alternative tool to improve cropping systems. A review. Agronomy for Sustainable Development,2011:31(2):379-395.
13. Duke SO, Baerson SR, Pan Z, Kagan IA, Sánchez-Moreiras A, Reigosa MJ, *et al*. Genomic approaches to understanding allelochemical effects on plants. In Allelopathy in Sustainable Agriculture and Forestry, 2008, 157-167.
14. Duke SO, Dayan FE, Rimando AM, Schrader KK, Aliotta G, Oliva A, Romagni JG. Chemicals from nature for weed management. Weed science,2002:50(2):138-151.
15. Farooq M, Jabran K, Cheema ZA, Wahid A, Siddique KH. The role of allelopathy in agricultural pest management. Pest management science,2011:67(5):493-506.
16. Ferguson RB, Luck JD, Stevens R. Developing prescriptive soil nutrient maps. Practical mathematics for precision farming, 2017, 149-166.
17. Field B, Jordán F, Osbourn A. First encounters–deployment of defence-related natural products by plants. New Phytologist,2006:172(2):193-207.
18. Finger R, Swinton SM, El Benni N, Walter A. Precision farming at the nexus of agricultural production and the environment. Annual Review of Resource Economics,2019:11:313-335.
19. Fisher RF, Woods RA, Glavicic MR. Allelopathic effects of goldenrod and aster on young sugar maple. Canadian Journal of Forest Research,1978:8(1):1-9.
20. Ghosh C, Das KBA. Allelopathic Effects of Some Dominant Weeds on Seed Germination and Seedling Growth of Tea, 2021.
21. Gioria M, Osborne BA. Resource competition in plant invasions: emerging patterns and research needs. Frontiers in Plant Science,2014:5:501.
22. Gliessman SR. Allelopathy as a potential mechanism of dominance in the humid tropics. Tropical ecology.,1978:19(2):200-208.
23. Gniazdowska A, Bogatek R. Allelopathic interactions between plants. Multisite action of allelochemicals. Acta Physiologiae Plantarum,2005:27(3):395-407.
24. Hussain WS. Effects of spraying aqueous extracts of some crop plants on growth of four types of weeds. Plant Archives,2020a:20(1):1460-1464.
25. Ilori OJ, Otusanya OO. Phytotoxic responses of some legumes and cereals to the phytotoxic activities of *Tithonia rotundifolia* (Miller) S.F. Blake. Ph.D. Thesis., 2013.
26. Ishii-Iwamoto EL, Abrahim D, Sert MA, Bonato CM, Kelmer-Bracht AM, Bracht A. Mitochondria as a site of allelochemical action. In Allelopathy, 2006, 267-284.
27. Jabran K, Farooq M. Implications of potential allelopathic crops in agricultural systems. In Allelopathy, 2013, 349-385.
28. Kaur S, Jabran K, Florentine S, Chauhan BS. Assuring Crop Protection in the Face of Climate Change Through an Understanding of Herbicide Metabolisms and Enhanced Weed Control Strategies. In Crop Protection Under Changing Climate, 2020, 17-56.
29. Keeler RF, Tu AT. Toxicology of plant and fungal compounds. M. Dekker., 1991**.**
30. Lal B, Oudhia P. Beneficial effects of allelopathy. I. crop production. Indian Journal of Weed Science,1999:31(1and2):103-105.
31. Laursen MS, Jorgensen RN, Midtiby HS, Mortensen AK, Baby S. Dicotyledon weed quantification algorithm for selective herbicide application in maize crops: statistical evaluation of the potential herbicide savings. International Journal of Agricultural and Biosystems Engineering,2017:11(4):272-281.
32. Li J, Chen L, Chen Q, Miao Y, Peng Z, Huang B, *et al*. Allelopathic effect of *Artemisia argyi* on the germination and growth of various weeds. Scientific reports,2021:11(1):1-15.
33. Lodhi MAK. Allelopathic effects of decaying litter of dominant trees and their associated soil in a lowland forest community. American Journal of Botany,1978:65(3):340-344.
34. Lovett JV, Jackson HF. Allelopathic activity of *Camelina sativa* (L.) Crantz in relation to its phyllosphere bacteria. New Phytologist,1980:86(3):273-277.
35. Mallik AU. Conifer regeneration problems in boreal and temperate forests with ericaceous understory: role of disturbance, seedbed limitation, and keytsone species change. Critical Reviews in Plant Sciences,2003:22(3-4):341-366.
36. Maqbool N, Wahid A, Farooq M, Cheema ZA, Siddique KHM. Allelopathy and abiotic stress interaction in crop plants. In Allelopathy, 2013, 451-468.
37. Molisch H. Einfluss einer pflanze auf die andere, allelopathie., 1937.
38. Mushtaq W, Siddiqui MB. Allelopathy in Solanaceae plants. Journal of Plant Protection Research, 2018, 58(1).
39. Mushtaq W, Siddiqui MB, Hakeem KR. Allelopathy: potential for green agriculture, 2020, 53-59.
40. Narwal SS, Tauro P. Allelopathic problems in Indian agriculture and prospects of research. Allelopathy in agriculture and forestry. Scientific Publishers, Jodhpur, 1994, 37-57.
41. Nelson CJ. Allelopathy in cropping system. Agronomy Journal,1996:88:991-996.
42. Raza Ejaz, Khalid Mahmood Chaudhary, Umair Talib, Inayatullah. Effectiveness of various chemical and non-chemical weed management practices as perceived by the farmers under cotton wheat cropping system in the Punjab. Int J Res Agron 2019;2(1):23-27. DOI: 10.33545/2618060X.2019.v2.i1a.14

43. Rice EL. Allelopathy. Academic Press, Orlando, FL. Allelopathy. 2nd ed. Academic Press, Orlando, FL., 1984.
44. Scognamiglio M, D'Abrosca B, Esposito A, Pacifico S, Monaco P, Fiorentino A. Plant growth inhibitors: allelopathic role or phytotoxic effects? Focus on Mediterranean biomes. Phytochemistry Reviews,2013:12(4):803-830.
45. Sowinski J, Dayan FE, Gląb L, Adamczewska-Sowinska K. Sorghum Allelopathy for Sustainable Weed Management. In Plant Defence: Biological Control, 2020, 263-288.
46. Whittaker RH, Feeny PP. Allelochemics: chemical interactions between species. Science,1971:171(3973):757-770.
47. Wyse DL. New technologies and approaches for weed management in sustainable agriculture systems. Weed Technology,1994:8(2):403-407.
48. Yu-xia WANG. The pollution of chemical pesticides to the environment and bioremediation measures (J). Territory & Natural Resources Study, 2008, 4.
49. Zeng RS. Allelopathy-the solution is indirect. Journal of Chemical Ecology,2014:40(6):515-516.
50. Zheng YL, Feng YL, Zhang LK, Callaway RM, Valiente-Banuet A, Luo DQ, *et al*. Integrating novel chemical weapons and evolutionarily increased competitive ability in success of a tropical invader. New Phytologist,2015:205(3):1350-1359.
51. Ogbe FMO, Gill LS, Iserhien EOO. "Effects of Aqueous Extracts of *C. Odorata* L. on Radical and Plumule Growth and Seedling Height of Maize, Z. mays L." Compositae Newsletters.,1994:25:31-38. Oklahoma Press, Norman.