The Role of Allelopathy for some Plants: A Review

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Abstract

Allelopathy is a widespread natural incident, which means that an organism creates biochemical substances that impact another species' evolution, persistence, advancement, and generation. Allelochemicals are biochemical substances that possess valuable or harmful impacts on target living beings. It is a naturally occurring ecological phenomenon of organism interference that can be used as insect pests, weeds and illnesses processer in field crops. Allelopathy can be employed in field crops after agriculture rotation, cover crops, and plant extracts for natural pest management. Weeds and insect pests can be effectively controlled by using allelopathic plant extracts. This review examines the nature of allelopathy, its significance in crops, their ability to tolerate or resist these materials, crop production, and the effect of these varied chemical compounds on exotic weeds on crops or microorganisms present in the environment where allelopathic substances are secreted as well as the allelopathic effect of some plants, such as sorghum, wheat, and rice, as well as the importance of these substances secreted from plants from various parts and liberated in different ways in the creator plant, which is dependent on the next mechanisms: decomposition, exudation, leaching, and volatilization.

Keywords: Allelopathy, phenolic compound, secondary metabolites, Wheat, Rice, weeds.

دور ألاليلوباثي لبعض النباتات: مراجعة

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المستخلص

تعد الأليلوباثي حالة طبيعية شائعة الانتشار تعني انتاج الكائن الحي للمواد الكيميائية الحيوية التي تؤثر على تطور الأنواع الأخرى وتحملها وتقدمها وتكاثرها. المركبات الكيميائية للاليلوباثي هي مواد كيميائية حيوية لها آثار مفيدة أو ضارة على الكائنات الحية المستهدفة. إنها ظاهرة بيئية تحدث بشكل طبيعي لتدخل الكائنات الحية والتي يمكن استخدامها لإدارة الأعشاب الضارة والآفات الحشرية والأمراض في المحاصيل الحقلية. لإدارة الآفات الطبيعية، يمكن استخدام المعاملة بالأليلوباثي في المحاصيل الحقلية بعد التناوب بالزراعة، وتغطية المحاصيل، والمستخلصات النباتية. يمكن مكافحة الحشائش والآفات الحشرية بشكل فعال باستخدام المستخلصات النباتية الأليلوباثية. تبحث هذه المراجعة في طبيعة الأليلوباثي وأهميتها في إنتاج المحاصيل الزراعية وقدرتها على تحمل او مقاومة هذه المواد، وتأثير هذه المركبات الكيميائية المتنوعة على الحشائش الغريبة على المحاصيل أو الكائنات الحية الدقيقة الموجودة في البيئة حيث تفرز المواد الاليلوباثية. فضلا عن التأثير الأليلوباثي لبعض النباتات مثل الذرة الرفيعة والقمح والأرز، وكذلك أهمية هذه المواد التي تفرز من النباتات من مختلف الأجزاء وتحررها بطرق مختلفة في النبات المنتج، والتي تقوم على الآليات الأربع التالية: التحلل والنضح والرشح والتطاير.

الكلمات المفتاحية: الاليلوباثي، المركبات الفينولية، الايض الثانوي، الحنطة، الرز، الادغال.

Introduction

Allelopathy is a complicated incident that includes both stimulatory and inhibitory impacts on plant activities caused by the liberation of particular chemical compounds termed allelochemicals. In response to biotic and abiotic stress, Allelochemicals, considered minor metabolites, are generated by a specific collection of plants and microorganisms. It is noted in this environmental phenomenon that there is an overlapping between the existing organisms. Allelopathic treatment can primarily reduce weeds and enhance plant resistance to pests and diseases (Xie et al., 2021). Its chemical structure ranks from a simple hydrocarbon to complex polycyclic aromatic compounds like "phenols, flavonoids, tannins, steroids, amino acids, alkaloids and quinones". These compounds are released into the environment by "decomposition, exudation, leaching and volatilization" which perform a considerable function in the organization of the relations between organisms (Singh et al., 2021). Drastic alterations in "temperature, drought, flood, excess or deficit of radiations like infrared, ionization, wounding, external pressure, wind and magnetic fields" are all classified under abiotic stress. Biotic stresses are in response to microorganisms, animals, and other plants, which affect the metabolic pathways through their influence on gene expression levels (Maqbool et al., 2013).

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https:// 10.36531/ijds.2023.139093.1031
Received 18 March 2023; Received in revised form 29 May 2023; Accepted 02 July 2023

The increase in allelopathic activity, which leads to a rise in allelochemicals concentration, occurs under the influence of biological stresses, and environmental conditions can control the increase or decrease in allelochemicals production in a specific geographical area (Scavo et al., 2018). Pedro et al. (2016) "mentioned that allelochemical production depends on stress type and quantity. The positive or negative impact of allelopathy is caused by any biochemical compound created by plants or microorganisms that affect the same or other plant species, plants, microbes, and microbes. In due course of time, with the advancement in metabolic engineering, some of these plant/microbe-derived compounds are explored as better candidates for industrial production of medicines, flavourings, anti-oxidants, plant growth promoting (PGP) and pesticides"(Basu et al., 2021). Most plant species produced allelochemicals as a secondary metabolite, but only a few appeared with allelopathic effects (Singh et al., 2021). Allelopathy negatively influences seed inefficiency or plant growth reduction by disrupting expected functionalities such as pollen germination, photosynthesis, cell division, nutrient uptake, ion imbalance and vital enzyme functions (Ferguson et al., 2013). This makes the allelochemicals a better alternative to synthetic herbicides and weedicides.

Allelochemical Production and Its Impact on Agricultural Productivity

Plants are sessile organisms that can adapt to the environmental conditions and alterations that affect their growth and survival. Plants gather information about nutrient availability and light from their surroundings, both below and above ground, and this information must be released from the donor plant to have any effect on the target plant. This can be achieved in different methods, including leaching from the shoot, volatilization from the green parts, release from decomposing material, and root exudates (Xie et al., 2021), as shown in (Figure 1). Excluding the release of allelochemicals during residue degradation, allelochemical production in living plants is a controllable process (decaying plant material). It is affected by several biotic variables, including adjacent plants (Hazrati et al., 2021) and their microbial underground companions, abiotic environmental circumstances such as temperature and light, and the developmental stage of the granter plant. In recent years, there has been a lot of scientific interest in the inducible synthesis of allelopathic compounds in an adjacent plant. Plant-plant molecular communication is an essential aspect of researching plant-plant interactions. Messenger molecules involved in indicative translocation lead to a complete restraint at the plant plane in the surrounding plant (van Dam and Bouwmeester,2016). It was also suggested that it could impact the production of minor chemicals having allelopathic potential (Kegge et al., 2015). "Allelochemical production or exudation appears to rise in response to the discovery of surrounding, competitive plant species, a phenomenon known as allelobiosis" (Li et al., 2016). Secretion of exudates from the root by various weeds, particularly *"Abutilon theophrasti*, *Aegilops tauschii*, *Amaranthus retroflexus*, and *Digitaria sanguinalis*" all increased phytoallelochemical aggregation in wheat (Li et al., 2016). In a test using a broader range of weed species, phytoallelochemical collection in wheat differed according to the conformity of the competing species (Kong et al., 2018). This implies that crop-weed recognition is species-specific, mediated by a diverse range of as-yet-unidentified signalling molecules. There is also evidence of allelochemical multi-kingdom function in the induction of allelochemical production; when herbivores, pathogens, or both are present, some allelochemicals aggregate in plants at abnormally large amounts. "Allelochemical accumulation in maize was generated by tissue disturbance or injury caused by the aphid *Rhopalosiphum padi* and the northern blight fungus *Setosphaeria turtica*, for example "(Ahmad et al., 2011). As a result, it is clear that plants, like other animals, recognize and respond to various biotic stresses. Moreover, these inducible allelopathic pathways appear familiar to many kingdoms of invasive species, including herbivores, pathogens, or both.

These compounds have inhibitory and stimulating effects on plants and microorganisms and on many vital activities. It is worth noting that the results of allelopathic compounds vary depending on their nature and concentration, as some compounds inhibit seed germination and growth while others stimulate it (Hussain and Abbas, 2021). The results of Al-jihashi (2005) revealed that sunflower *Helianthus annuus* L. plant residues at various growth phases (seedling, elongation, flowering, and maturity) reduced the germination and growth of wheat types *Triticum aestivum* L. and two types of *Helianthus annuus* L., indicating that the flowering stage of the examined species showed a noticeable allelopathic effect when compared to the other phases. In another investigation, the two researchers found that adding tomato and rice residues to the soil inhibited growth and several yield attributes of wheat types growing in soils with rice residues, while tomato residues increased these traits. The amount of allelochemicals generated by ecosystems in crop combinations is determined by Environmental conditions (temperature, water, and soil nutrient level), planting strategies, and crop species (Malézieux et al., 2009).

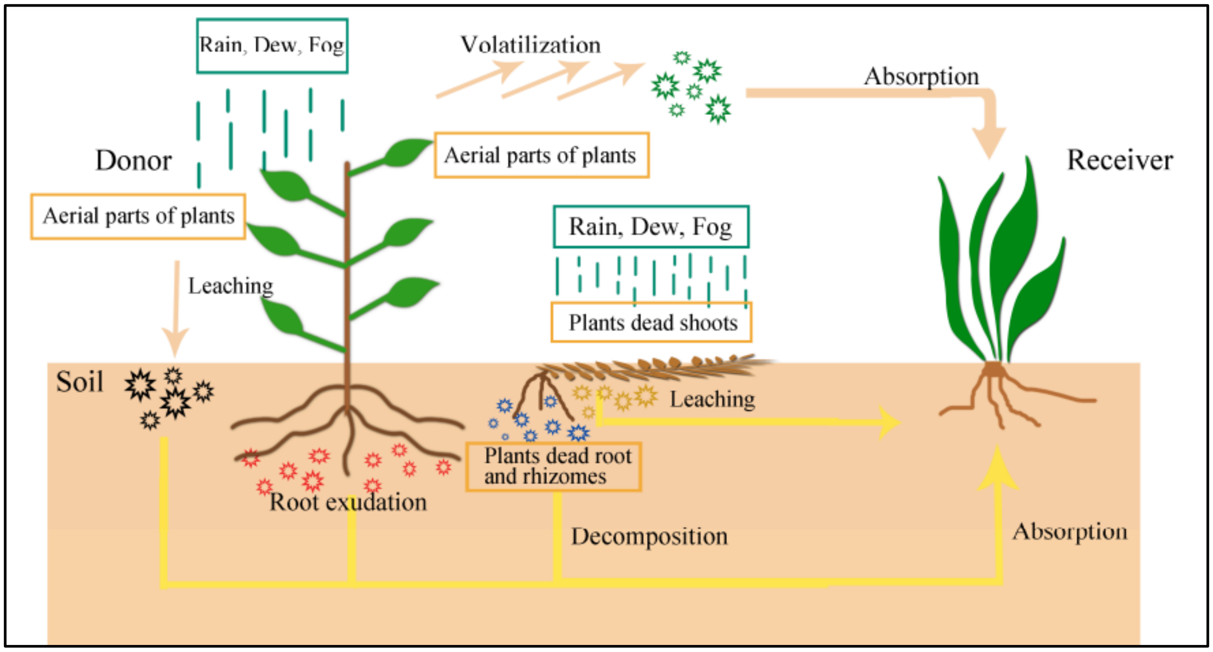


Figure 1. Plant allelopathic pathways (Hazrati et al., 2021).

Allelochemical resistance and tolerance

During growth and development, plants can create various secondary metabolites. Plants Volatile Organic Compounds **(**VOCs) differ between types and are regarding both diversity of surrounding plant types and their compilation (Kigathi et al., 2019). Minor metabolites can benefit or harm other living beings when they are kept or released into the environment. For instance, secondary metabolites that remain in plants might guard against microbial contamination and animal grazing, but volatiles released into the atmosphere can draw insect pollinators (Kessler and Baldwin, 2001). To interact with other species in the environment and affect their growth, development, protection, reproduction, and life cycle (Bouwmeester et al., 2019), plants employ volatile organic compounds (VOCs). The leading cause of such compounds' limited universality may be the evolution of tolerance or resistance by a target species in its natural habitat. Numerous plant species, for instance, and several Fusarium species (Niemeyer,2009), have acquired the capacity to detoxify benzoxazinoids (Von Rad et al., 2001).

Similarly, *low Alliaria petiolata glucosinolate chemical levels in the rhizosphere* due to partial breakdown by the local population are associated with the eventual sensitivity of these bacteria to these compounds (Lankau,2011). "The Red Queen hypothesis states that insect herbivores can develop tolerance to secondary plant chemicals, which enables them to bypass zoo allelopathic defences through counter-resistance evolution. This is especially true when a single gene controls host resistance, as in the case of lettuce, which had only been reluctance to the aphid *Pemphigus bursarius* for five years before the aphid developed an opposite reluctance to it (Smith and Chuang, 2014)". Similar dynamics have been developed by several lepidoptera to glycosylate DIMBOA back to its safe storage state. "BOA (benzoxazine-2-one), a byproduct of DIBOA breakdown, may also be detoxified in Arabidopsis by the enzymes glutathione transferase (GST) and cytochrome P450 monooxygenase (CYPP450)" (Wouters et al.,2014). Therefore, from an ecological perspective, counter-selection will eventually exceed the benefit of new armament. Native species will gradually develop resistance to the allelochemicals of an invasive plant type, but this needs the invader to become predominant and trouble the environment, creating substantial selection pressure. Overuse of these pesticides makes it harder to control insects.

resistant species and the efficiency of synthetic herbicides is also declining. Pre-adaptation dynamics must be further studied to enable more efficient administration of biocides produced from allelochemicals (Hardy et al.,2018).

Sorghum Allelopathy

Allelochemicals produced through various plant components rely on a variety of variables, including the crop family that was used, the size and amount of mulch used, the rate of decomposition, moisture content, soil texture, and soil microbiota (Khaliq et al., 2014). The dosage of allelopathic agents is closely correlated with the extent of weed suppression (Khaliq et al., 2011). The overall quantity of allelochemicals in the mulch and released increases when more plant material is employed as mulch, resulting in a more significant concentration of allelochemicals in the soil (Shehzad and Okuno,2020). More agricultural leftovers were added, which led to more excellent weed suppression.

To reduce the weed population in field crops, it is possible to incorporate allelopathic crops into different crops (Głąb et al.,2017). Due to sorghum allelochemicals' reduced weed seed germination, crops that follow Sorghum have lower weed populations (Farooq et al., 2017). Several secondary metabolites, including "alkaloids, flavonoids, phenolics, hydroxamic acids, momilactone, terpenoids, jasmonates, glucosinolates, brassinosteroids, and salicylates have been found in the sorghum plant (shoot and roots) in earlier investigations (Jabran and Farooq, 2013). Chlorogenic acid, benzoic acid, gallic acid, vanillic acid, caffeic acid, p-hydroxybenzoic acid, syringic acid, p-coumaric acid, ferulic acid, and protocatechuic acid are among the phenolics found in Sorghum (Hassan et al.,2012)". The behaviour of farmed sorghum species inhibits weed growth (Rasul and Ali,2020). Sorghum mulch and sorghum water extracts may help crops by lowering weed pressure since they contain these allelochemicals (Farooq et al., 2017).

Numerous organic substances that are both hydrophilic and hydrophobic and have allelopathic potential are released by the root hairs of Sorghum (Uddin et al., 2009). "Compound 2-hydroxy-5-methoxy-3-[(Z, Z) - 8',1 l',14'-pentadecatriene]-p-hydroquinone which is hydrophobic component which oxidizes readily into the quinone, and three minor p-benzoquinones that are similar in structure, sorgoleone is stable quinone inhibited the root development of lettuce and other weed species "(Uddin et al., 2012). The impact of sorgoleon and sorghum root extract on the germination and growth of agricultural and weed plants has recently attracted more attention (Naby and Ali,2020). "This substance has been discovered to behave in a variety of ways, including by inhibiting the activity of the photosynthesis-related enzyme p-hydroxyphenylpyruvate dioxygenase (HPPD), root H^+-ATPase, and mitochondrial and photosynthetic electron transport"(Weston et al., 2013). Many research on the phytotoxic activity of sorgoleone investigated that its mechanism of action targets the photosynthetic electron transport chain (Czarnota et al., 2001), as shown in (Figure 2).

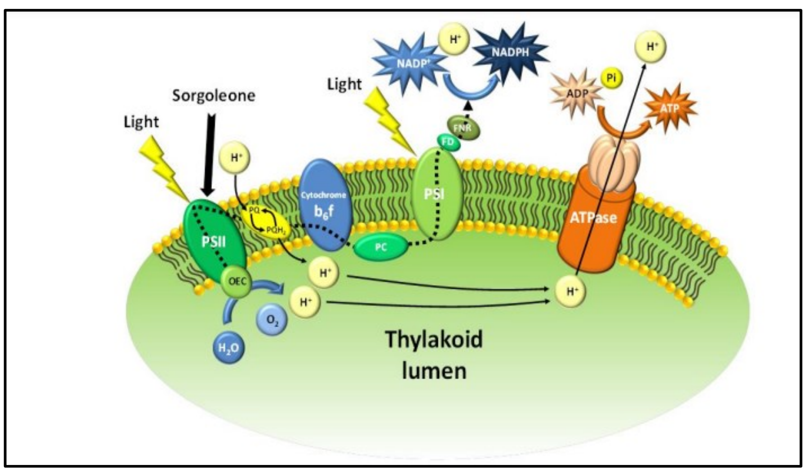


Figure 2. Schematic of the light reaction of photosynthesis (Hill reaction or Z-scheme) and the location of the binding site of sorgoleone in the D1 protein of photosystem II (PSII). PC=plastocyanin, PSI=photosystem I, PQ=plastoquinone, Figure adapted from (Dayan and Duke, 2014).

Structurally, sorgoleone is similar to plastoquinone (a lipid benzoquinone), resulting in competition with the natural electron acceptor at the plastoquinone binding site on the D1 PSII protein. Numerous researchers, such as Hussain et al. (2021), reported that Sorghum had the most remarkable propensity for allelopathy. It has been demonstrated that sorghum allelochemicals prevent the growth of grassy and broad-leaved weeds (Farooq et al., 2020). When compared to the control group, Cheema and Khaliq (Cheema and Khaliq,2000) found that spraying water extract of mature sorghum crop plants reduced weed density and biomass by 35-49%. More successfully than sorghum water extract, sorghum residue treatments decreased weed biomass in the soil by 40–50%. Sorghum was added at a rate of 2–6 Mg ha^1. Crop residues can alter weed frequency and distribution and decrease weed growth (Khaliq et al.,2015).

The physical resistance provided by including corn remains, or the liberation of compounds from these remains may have contributed to this experiment's growth inhibition of the main weed biota (Farooq et al.,2020). Alsaadawi et al. (2013) carried out a two-year field study. They claimed that adding sorghum residue considerably decreased the number of weeds and increased the output of broad beans compared to weedy checks. According to results of Ullah et al. (2022), utilizing sorghum residues as allelopathic weed suppression techniques in mung bean crops enhanced the soil's microbial population and enzymatic activity. The addition of sorghum residues increased the formation of root nodes, thus raising the efficiency of the nitrogen fixation process, as well as the chemical, physical, and nutritional status of soil fields, in addition to having a beneficial impact on weed biomass and population. According to our findings, as crop residue levels have grown, the soil's bulk density and overall porosity have both reduced over time. The increased soil moisture retention may be responsible for nutrient aggregation, particularly Phosphorus and Potassium (Hussain et al.,2021). The soil's capacity to hold water was also increased by including residues, so the soil's wetness was accessible for extended periods to share plant development (Jin et al.,2013). Future research should look at how this improvement in moisture retention qualities can reduce the crops' need for irrigation. Sorghum bicolor L. root exudates may be a bioherbicide to manage grassy weeds in wheat fields (Naby and Ali,2021).

Allelochemicals released by weed plants' roots, particularly the highly strong photosynthesis inhibitor sorgoleon (a hydrophobic phytotoxic molecule) from *S. bicolour* L., have been observed to have stunted weed plant development (Shaikh et al.,2019). Sorghum root extract, a bioherbicide, significantly impacted seed germination. It prevented the growth of the test plants' seedlings, including mung bean (*Vigna radiate*) and rice (*Oryza sativa*). The test plant treatment significantly impacted the radicle and plumule length, fresh and dried weights, and weights of the radicle and plumule (Setyowati et al.,2021). Solymosi and Bertrand (Solymosi and Bertrand,2012) investigated whether ethanolic sorghum root extract on wheat and corn inhibits the germination and development of plants. The aqueous extract of sorghum stem inhibits germination, rootlet development, vigour index of lentils and maize, and wheat seed germination.

Additionally, as revealed by other researchers like Judi (Judi,2015), its degraded residues hinder the germination and development of rootlets and shoots in other plants. For instance, using water extracts of brassica, mulberry (*Morus alba* L.), and Sorghum in maize decreased the density and dry biomass of horse purslane (*Trianthema portulacastrum* L.) and purple nut sedge (*Cyperus rotundus* L.) compared to control (Ihsan et al.,2015). When applied to maize cultivated in either cropping system, sorghum-based treatments dramatically reduced weed biomass and density, according to (Naeem et al.,2016).

Wheat Allelopathy

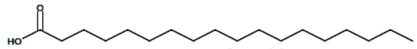
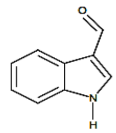
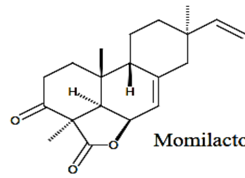
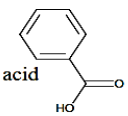
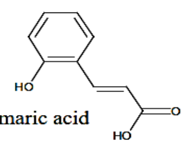
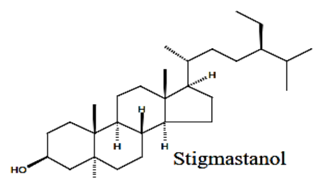
Allelopatically active chemicals are known to have an activating or inhibiting influence on plant growth and evolution, as well as several metabolic processes. As a result, they can operate as natural regulators of growing plants, depending on their concentration and environmental factors (Giancotti et al.,2020). According to scientific research, winter wheat possesses allelopathic qualities for weed, insect, and disease management that may be employed in plant preservation and will help its production organically (Li et al.,2019). It could be shown that the production of DIMBOA "benzoxazinones 2,4-dihydroxy-7-methoxy-(2H) − 1,4-benzoxazin-3(4H)-one " is activated by wheat root secretions produced from nearby plants (Zhang et al.,2016). Phenolic substances "(vanillic, ferulic, syringic, and p-coumaric acids) and root exudates of BXZ (benzoxazolin-2-one (BOA), 2-hydroxy-7-methoxy-1,4-benzoxazin-3-one (HMBOA), 2-hydroxy-1,4-benzoxazin3-one (HBOA), and 2, 4-dihydroxy-1,4-benzoxazin-3-one (DIBOA) were increased in wheat tissues (shoots, roots) and exudates in root rhizosphere agar medium following co-growth with either *L. rigidum* or *P. oleracea* "(Hussain et al.,2022). Macías et al. (2006) described the biological properties of the BXZ metabolites. Some unique benzoxazine such as "2,4-dihydroxy-(2H)− 1,4-benzoxazine-3(4H)-one and 2,4-dihydroxy-7-methoxy-(2H)− 1, 4-benzoxazine-3(4H)-one, and the phenoxazinone APO showed significant inhibition of both wild oat and rigid ryegrass". In contrast to their BXZ predecessors, "phenoxazinones" They are often less labile in the root zone (Mwendwa et al.,2021): transport proteins or passive diffusion discharge root exudates from root hairs and epidermal cells in roots. Even though benzoxazinoids are present and are transported into the root apoplast (Ahmad et al.,2011), it is not known how root exudation works. Others have claimed that passive transport is how benzoxazinoid exudation happens (Niculaes et al., 2018), although this is improbable given the usage of natural hydroxamic acids and BXZ metabolites.

The allelopathic impact varied when a mesh was used to prevent direct contact between the wheat root and weed types, indicating that root contact may be necessary for wheat allelopathy and may only apply to a specific weed type (Zhang et al.,2016). Additionally, Kong et al. (2018) observed that wheat could produce DIMBOA in response to at least 100 different plant species, and given that various species' root exudates included collide and JA (jasmonic acid), These molecules are supposed to act as underground signal transmitters. By using these common signalling molecules, wheat plants can identify conspecific (of their species) and heterospecific (from other species) neighbours early in their development, which causes them to produce more of the allelochemical DIMBOA (Eroğlu et al.,2022). Various wheat tissues or organs, including roots, branches, and entire plants, have been shown to have allelopathic activity (Zuo et al.,2007), with seeds and their extracts being more phytotoxic than other plant tissues. Herbicide-resistant weeds like *Lolium rigidum* Gaud have had their radicle length and ability to germinate reduced by wheat allelochemicals. According to Wu et al. (2003), in a repeated laboratory wheat accession experiment, wheat allelopathy dramatically reduced germination in annual ryegrass ecotypes that were both herbicide-resistant and herbicide-susceptible, with an inhibition that varied from 3% to 100%. The measure of root development that was assessed had a higher sensitivity to wheat seedlings and exudates than seedling germination. Both the susceptible and resistant ecotypes of annual ryegrass were affected by the presence of "p-coumaric acid and propionic acid" found in wheat remnants (Wu et al.,2003). This was further supported by Mwendwa et al. (2021), who used sophisticated metabolomics from the rhizosphere and rhizoplane together with wheat root extracts in field tests. Under co-culture circumstances, root secretions from the wheat cultivar Ursita reduced *Lolium rigidum* seedling growth (29–60%) and photosynthetic pigments (Hussain et al.,2022). The use of wheat straw as a soil treatment resulted in many phenolic compounds in that soil, and wheat straw's incorporation or usage as a surface mulch proved harmful for the nearby maize seedlings (Opoku et al.,1997). Competitive features of cereal crops vary by year, location, agronomic techniques, and environmental conditions, which may undoubtedly impact how well particular crop genotypes control weeds (Worthington et al.,2015). However, Krumsri et al. (2020) assert that because shoot extracts include more phenolic chemicals than root extracts, they significantly inhibit rice seed germination.

Rice allelopathy

In many countries, rice is one of the most critical, irreplaceable staple foods and this crop's availability is correlated with food security. The monocot plants *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice), which are members of the grass family Poaceae and have twenty wild species as well as two cultivated varieties each, are the source of rice (Tegegne et al., 2020). Since rice is a staple meal for most people, the expanding global population has significantly focused on raising food production, which has allelopathic and non-allelopathic varieties. To prevent paddy weeds from growing and spreading, allelopathic rice cultivars can create and release allelochemicals (Serra Serra et al., 2021). These chemicals are a practical part of integrated weed control (Table 1). According to recent research, rice cultivars may recognize their kin and allelopathic rice cultivars with this ability can modify root activity and biomass distribution, enhancing seed yield (Yang et al., 2018). Some colored rice cultivars can exude root exudates containing allelochemicals, preventing the growth of weeds and other plant species. If rice is to compete with weeds starting at the germination stage, this capacity is necessary. Barnyard grass, one of the most pervasive weeds in rice fields, can harm rice development at every stage, notably during germination (Kadapi et al., 2021).

Table 1. Main allelochemicals identified from rice (Khanh et al.,2007)

Chemical class	Constituents	Representative structure	Occurrence
Cytokinins	Cytokinins		Root exudates
Fatty acids	Stearic acid Azelaic acid	 Stearic acid	Soil
Indoles	1H-indole-3-carboxaldehyde 1H-indole-3-carboxylic acid 1H-indole-5-carboxylic acid Indole-5-carboxylic acid	 1H-Indole-3-carboxaldehyde	Root exudates
Momilactones	Momilactone A and B	 Momilactone A	Hulls, leaves and straw; root exudates
Phenolic acids	Benzoic acid Caffeic acid Ferulic acid *m*-Coumaric acid *o*-Coumaric acid *p*-Coumaric acid *t*-Coumaric acid Gallic acid Gentisic acid *p*-Hydroxybenzoic acid Salicylic acid Protocatechuic acid Mandellic acid Synapic acid Vanillic acid Syringic acid	Benzoic acid   *o*-Coumaric acid	Straw, decomposed straw, root exudates, leaves and stem, soil, hulls
Steroids	Stigmastanol Ergosterol peroxide 7-Oxo-stigmasterol	 Stigmastanol	Hulls, fresh roots and aerial parts
Other constituents	1,2-Benzenedicarboxylic acid bis (2-ethylhexyl)ester 2-Methyl-1,4-benzenedio 1-Phenyl-2-hydroxy-3,7-dimethyl- 11-aldehydic-tetradecane-2-b-D-glucopyranoside 3-Hydroxy-4-methoxybenzoic acid 3-Isopropyl-5-acetoxycyclohexene-2-one-1 4-Ethylbenzaldehyde 2- and 4-Hydroxyphenylacetic acid 5-Hydroxyindole-3-acetic acid 4-Phenylbutyric acid Abietic acid Lanast-7,9(11)-dien3a,15a-diol-3a-D-glucofuranoside Resorcinols		Root exudates, hulls, hull extracts, soil, straw

Weeds are harmful plants that produce little economic yield for farmers and are otherwise challenging for farmers to manage (Mushtaq et al.,2020). It also requires careful management to reduce the impact of weeds on agricultural yields. This is especially alarming since barnyard grass, primarily found in rice but also widely planted in agricultural fields, is one of the top 15 weed species that can develop herbicide resistance, with cases recorded in 23 countries. In addition to its tillering solid capacity and profusion, this species is one of the most often reported concerns around the globe (Tian et al.,2020) because of its ecological and biological similarity to rice.

Using synthetic chemicals as herbicides to manage weeds in rice fields over a number of years eventually resulted in environmental problems and the creation of herbicide-resistant rice weeds (Lushchak et al.,2018).

Therefore, one crucial step in reducing the harmful effects of herbicides is the creation and cultivation of allelopathic rice that can emit allelochemicals that harm weeds or have an inhibitory effect on them (Kong et al., 2019).

The combined functions of kin identification and interspecies allelopathy in plant-plant interactions are thus best understood using allelopathic rice interaction with paddy weeds as a model system. Rice varieties that are allelopathic develop and emit allelochemicals to combat paddy weeds. There must be a trade-off between expansion and defense because allelochemical production also has a defensive cost (Meiners et al., 2012). Depending on who its neighbours are, a plant may alter its protective approach. In this regard, co-occurring plant species are also necessary for the formation of allelochemicals (Kong et al., 2018).

Conclusion

In addition to managing weeds, diseases, and insects, allelopathy plays a significant role in cultivar development and studying optimal agricultural systems. Allelochemicals can also be safe insecticides, fungicides, herbicides, and plant growth regulators. They might, however, be quite expensive in sustainable agriculture. Sorghum, wheat, rice, and many other plants have an allelopathic function by secreting chemicals that influence invaders, weeds, and nearby plants. This increases production, protects the species, and lowers the price of plant loss due to this condition. Therefore, allelopathic interaction may be the main element affecting the connection between nearby plant species. Including allelopathic crops in agricultural rotations, using them as cover crops, and mulching can all help manage weeds. Most research continues to focus on the manifestations of allelopathic phenomena, but its depth and scope are severely insufficient. Insufficient research on plant allelopathic mechanisms, the link between chemical-specific recognition and communication systems and allelopathic mechanisms, and many other factors are examples. Under the correct conditions, these chemicals may be released into the environment in an amount that affects adjacent plants. Numerous aspects of plant ecology, including dominance, biodiversity, production, development, and phenology, can be impacted by allelopathy, plant succession, and community organization.

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