




Review

Allelopathic Properties of Lamiaceae Species: Prospects and Challenges to Use in Agriculture

A. K. M. Mominul Islam ^{1,*}, Thiti Suttiyut ^{2,3}, Md. Parvez Anwar ¹, Abdul Shukor Juraimi ⁴ and Hisashi Kato-Noguchi ⁵

¹ Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh; parvezanwar@bau.edu.bd

² Department of Horticulture and Landscape Architecture, Purdue University, 625 Agriculture Mall Dr, West Lafayette, IN 47907, USA; tsuttiyu@purdue.edu

³ Purdue Center of Plant Biology, Purdue University, West Lafayette, IN 47907, USA

⁴ Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia; ashukur@upm.edu.my

⁵ Department of Applied Biological Science, Faculty of Agriculture, Kagawa University, Miki 761-0795, Japan; kato.hisashi@kagawa-u.ac.jp

* Correspondence: akmmominulislam@bau.edu.bd; Tel.: +880-1718-512082

Abstract: Herbicide resistance due to the increasing reliance on herbicides is a near-term challenge for the world's agriculture. This has led to a desire to develop new herbicides with a novel mode of action, to address resistance in weed species. Lamiaceae, a large dicotyledonous plant family, is very well known for the multitudinous pharmacological and toxicological properties of its member species. Moreover, many species of this family are significant for their allelopathic activity in natural and laboratory settings. Thus, plants in Lamiaceae have the potential to be sources of alternative herbicides. However, gaps in our knowledge need to be addressed prior to adopting these allelopathic activities in agriculture. Therefore, we review the existing state of knowledge about the Lamiaceae family, the reported allelopathic properties of plant extracts, and their isolated allelochemicals under laboratory, greenhouse, and field conditions. In addition, we offer a perspective on existing challenges and future opportunities for adopting the allelopathic properties of Lamiaceae plant species for green agriculture.

Keywords: allelochemicals; ecology; biodiversity; green agriculture; natural products; weed management



Citation: Islam, A.K.M.M.; Suttiyut, T.; Anwar, M.P.; Juraimi, A.S.; Kato-Noguchi, H. Allelopathic Properties of Lamiaceae Species: Prospects and Challenges to Use in Agriculture. *Plants* **2022**, *11*, 1478. <https://doi.org/10.3390/plants11111478>

Academic Editors: Adriano Sofo, Anamaria Mălinaș and Magdalena Szymura

Received: 11 May 2022

Accepted: 30 May 2022

Published: 31 May 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The direct or indirect detrimental or advantageous effects of a plant to its neighboring plants, or the plant itself, through the release of chemical substances are known as allelopathy, and the released substances are called allelochemicals [1]. Allelochemicals are present in nearly all plant tissues, including leaves, stems, rhizomes, roots, flowers, pollen, fruits, and seeds [2]. These allelochemicals are released into the environment through leaf or stem leaching (through precipitation), volatility (predominantly in semi-arid and arid conditions), root secretion, and tissue degradation by microorganisms [3]. Some allelochemicals can be released together and may exert toxicities in an additive or synergistic manner [4]. Upon release, allelochemicals may either inhibit or stimulate the growth of surrounding plants [2].

The present agricultural production system is impossible to imagine without the application of synthetic chemical pesticides. The high efficacy, cost-effectiveness, rapid return, flexibility, and easy accessibility of pesticides are the main reasons for such dependence [5]. The labor shortage due to outmigration from agriculture to other sectors also fuels the flames [6]. However, inappropriate dosages, application times and techniques, and/or storage practices [7] can cause various adverse effects for off-target organisms and farmers'

health [8,9]. Continued use of the same pesticides has also increased the rate at which pests develop resistance to the available chemical active ingredients. For example, to date, a total of 512 unique cases of herbicide-resistant weeds have been reported in 96 crops from 71 countries [10]. Going ahead, developing new pesticides will be restricted by harsh environmental, toxicological, and regulatory requirements [11]. This backdrop opens the door to producing natural product-based pesticides. In this context, the allelopathic properties of plants or their isolated allelochemicals may play a vital role. Although the inhibitory properties of the allelochemicals against test species are the main focus for most of the allelopathic studies [12], the biostimulatory activity of these chemicals to the target species at lower doses has also attracted the attention of many researchers [13].

Therefore, it is worth exploring the use of allelopathy in agriculture and studying the determinants preventing it from being implemented as a chemical tool. Lamiaceae is a large plant family and has been intensively studied and used in many applications [14,15]. Moreover, many species in Lamiaceae exhibit strong allelopathy. Hence, this review provides an overview of the present state of knowledge about the allelopathic properties of Lamiaceae plant species and their bioactive substances. This review also addresses the challenges and prospects of using Lamiaceae plants or their bioactive compounds in agriculture and the gaps for further research.

2. Lamiaceae in Brief

Lamiaceae (also known as Labiatae or the mint family) is a dicotyledonous aromatic plant family of the Angiosperm order Tubiflorae [16], comprising more than 250 genera and 7000 species [17]. The family is commonly distributed in temperate regions. It is one of the most commercially important plant families, and known for its pharmacological, pharmaceutical, and toxicological properties (Table 1). Most of the species are shrubby or herbaceous in nature, but a limited number of *Hyptis* and *Leucospectrum* are small trees; while *Gomphostemma* is a rain forest tree genus and a few species of *Scutellaria* are climbers [16]. Mainly they are xerophytes, but a few are hygrophytes, e.g., *Stachys palustris* [18,19]. The most distinct feature of Lamiaceae is being aromatic, because of the presence of significant quantities of volatile oils e.g., terpenes and their oxygenated derivatives, which are commercially important. Alkaloids are hardly present in this family. Some other substances such as glycosides, saponins, and resins are occasionally present [20]. The presence of these chemicals may confer economic value, and the toxic potential or allelopathic properties make this family one of the most interesting plant families to researchers [21]. A significant number of plant species of this family have medicinal value [20–25]. Plants belonging to the *Teucrium*, *Salvia*, *Dracocephalus*, *Thymus*, *Coleus*, and *Lavandula* genera are considered important ornamental species. Besides these, around 175 species of 45 genera of this family are considered weeds in different parts of the world [26].

A large number of Lamiaceae plant species, such as *Salvia officinalis* L. (Sage) [27], *Thymus vulgaris* L. (Thyme) [28], *Calamintha nepeta* L. (Lesser Calamint) [29], *Leucas aspera* Linn. (Thumbai) [30], *Origanum vulgare* L. (Oregano) [31], *Hyptis suaveolence* L. (Pignut) [32], *Satureja hortensis* L. (Summer Savory) [33,34], *Nepeta meyeri* Benth. (Catmint) [35], *Rosmarinus officinalis* L. (Rosemary) [36–39], and *Tectona grandis* L.f. (Teak) [40] show allelopathic and/or phytotoxic potential. The phytotoxic effect of their extracts, especially essential oils (EOs), was linked to the presence of volatile bioactive compounds [41–43].

Table 1. List of major genus and species of the Lamiaceae family, with their distribution and special characteristics.

Sl. No.	Genus Name	Total No. of Species	Distribution	Chemical Constituents *	Medicinal and/or Industrial Properties	Reference
1	<i>Salvia</i>	900	Throughout the Old world (Asia, Africa and Europe) and new world (Americas)	Sesquiterpenoids, diterpenoids, sesterterpenoids, triterpenoids, steroids, polyphenols, etc.	Antioxidative, antibacterial, hypoglycaemic, anti-inflammatory, fungistatic, virustatic, astringent, eupeptic, anti-hydrotic, and cardioprotective properties. Used as spices and flavoring agents.	[44–47]
2	<i>Nepeta</i>	280	Native to temperate Europe, Asia, Africa, and are naturalized in North America	Nepetalactone (and its isomers), 1,8-cineole, β -caryophyllene, caryophyllene oxide, β -farnesene, α -citral, β -citronellol	Diuretic, diaphoretic, antitussive, antispasmodic, antiasthmatic, febrifuge, emmenagogue, sedative, antitumor, anti-inflammatory, antimicrobial, feline and canine attractant, insect repellent, arthropod defense, antibacterial, antifungal, and antiviral properties. Used as a perfume and flavoring agents.	[48–53]
3	<i>Ocimum</i>	160	Widely distributed throughout the tropical and sub-tropical Asia	Eugenol, thymol or sesquiterpene alcohols as major or terpene compounds as minor oil constituents	Anti-diabetic, anti-oxidant, anti-microbial, antinociceptive, anti-fertility, anti-inflammatory, anti-cancer, anthelmintic, cardioprotective, etc.	[54–56]
4	<i>Lavandula</i>	30	Native to the Mediterranean region, but is grown in many other countries of the world	Linalool, linalyl acetate, 1,8-cineole β -ocimene, terpinen-4-ol, and camphor	Anticancer, antimutagenic, antioxidant, antimicrobial, anxiolytic, mood stabilizer, sedative, analgesic, anticonvulsive and neuroprotective properties. Used for the treatment of epilepsy, migraine attacks, pain and tremor. Also used in perfume, cosmetic industry, and aromatherapy.	[57–60]
5	<i>Mentha</i>	42	Northeastern Africa, western Asia and southeastern Europe	Menthol	Insecticidal, antibacterial, antifungal, anti-cancer, pharmaceutical, flavoring and cosmetic properties. Used for treating wounds, swollen glands, cough, cold, fever, asthma, indigestion, influenza, vomiting, gastro-intestinal disorder.	[61–68]

Table 1. Cont.

Sl. No.	Genus Name	Total No. of Species	Distribution	Chemical Constituents *	Medicinal and/or Industrial Properties	Reference
6	<i>Thymus</i>	400	Native to Europe	Several types of monoterpenes, p-cymene, γ -terpinene and thymol	Antiseptic, antihelminthic, expectorant, antispasmodic, antimicrobial, antifungal, antiviral, antioxidative, carminative, sedative, antiviral, diaphoretic, antibacterial, antispasmodic, antirheumatic, antihypertensive, anti-inflammatory, and pharmaceutical properties. Used for the treatment of skin (oily skin, acne, dermatitis), eczema, insect bites, digestive, cardiovascular, nervous systems, nausea and fatigue, respiratory (such as colds), menstrual and menopausal problems, etc.	[69–74]
7	<i>Hyptis</i>	150	Tropical America, but now distributed throughout the world from tropical to subtropical regions.	Urosolic acid, alkaloids, terpenes, and volatile oils	Natural HIV-integrase inhibitor, antispasmodic, antirheumatic, anti-inflammatory, antifertility agents, antiseptic, appetizer and insecticidal properties. Used for diabetes and cancer treatments.	[32,75–78]
8	<i>Leucas</i>	80	Tropical and temperate Asia, and Africa	Lignans, flavonoids, coumarins, steroids, terpenes, fatty acids, and aliphatic long-chain compounds	Analgesic, antipyretic, anti-rheumatic, anti-venom, anti-inflammatory, antibacterial, antifungal, and mosquito repellent properties. Used for coughs, colds, painful swellings, and chronic skin eruption treatment.	[25,79,80]
9	<i>Leonurus</i>	20	Europe and Asia, naturalized in New Zealand, Hawaii, New Caledonia, and America	Diterpenoids	Analgesic, anti-inflammatory, anti-bacterial, antiproliferative, antioxidative, anticancer, cardioprotective, neuroprotective properties. Used for treating chronic rheumatism, menstrual irregularities, and heart disorders.	[22,81–85]
10	<i>Origanum</i>	900	Europe, Central Asia, and North America	Carvacrol, Thymol, γ -terpinene, p-cymene, β -cymene, Methyl Eugenol, myristicin	Anti-fungal, anti-bacterial, anti-tumor, anti-inflammatory, anti-oxidant, anti-cholinesterase, anti-parasitic, anti-viral, and anti-diabetes properties.	[86–88]
11	<i>Rosmarinus</i>	3	Native to the Mediterranean areas, and widely distributed in many parts of the world	α -pinene, verbenol, verbenone, 1,8-cineol and isoborneol	Antimicrobial, antioxidant, antibacterial, antimycotic, food flavoring, and food preservative properties.	[89–91]

Table 1. Cont.

Sl. No.	Genus Name	Total No. of Species	Distribution	Chemical Constituents *	Medicinal and/or Industrial Properties	Reference
12	<i>Hyssopus</i>	36	Highly abundant on dry, rocky, calcareous soils in Europe, southwest and central Asia, and north-west India	Pinocamphone, α -pinene, β -pinene, apigenin, quercetin, diosmin, luteolin, chlorogenic, protocatechuic, ferulic, syringic, p-hydroxybenzoic, and caffeic acids	Used for the treatment of stomachic, chronic bronchitis, rheumatic pains, bruises, wounds, blood pressure regulation, states of anxiety, hysteria. Has muscle-relaxing, antiseptic, insecticidal, nematocidal, antibacterial, antifungal, and antioxidant properties.	[92–97]
13	<i>Orthosiphon</i>	40	Tropical and subtropical Asia including Southern Africa and Madagascar	Polymethoxylated flavonoids, phenylpropanoids (caffeic acid derivatives), and terpenoids (mainly diterpenes and triterpenes)	Used for the treatment of urinary lithiasis, edema, rheumatism, hepatitis, diabetes, hypertension, oedema, epilepsy, fever, influenza, tonsillitis, menstrual disorder, gonorrhoea, syphilis, and jaundice.	[98–101]
14	<i>Tectona</i>	3	Indian subcontinent, throughout Myanmar and Thailand	Triterpenoids, flavonoids, chromomoric acid derivatives, anthraquinones, naphthoquinones, anthraquinone-naphthoquinones, apocarotenoids and lignans	Used for bronchitis treatments, hyperacidity, dysentery, verminosis, burning sensation, diabetes, difficult labor, leprosy, skin diseases, stomatitis, indolent ulcers, headache, biliousness, burning pains, etc. Have hemostatic, anti-inflammatory, antibacterial, antifungal, analgesic, cytotoxic, hypoglycemic properties.	[40,102–104]
15	<i>Satureja</i>	200	Mediterranean region, Asia, and some parts of USA	Thymol, carvacrol, cymene, flavonoids, tannins, linalool, γ -terpinene	Antimicrobial, antioxidant, anti-inflammatory, anti-parasitic, anti-viral, analgesic, antinociceptive, anti-diabetic, anti-cancer, and anti-hypercholesterolemic properties.	[105–107]
16	<i>Conradina</i>	6	Xeric with well-drained sandy soil areas of US	Camphor, 1,8-cineole, ursolic acid, cis-punocamphone, botulin, α -pinene, p-pinene, myrtenal, myrtenol, verbenone, myrtenyl acetate, limonene, camphene, β -amyrin, β -caryophyllene, β -pinene, β -cubebene, myrtenic acid	Antibacterial, antifungal, cytotoxic, antileishmanial properties.	[108,109]

Table 1. Cont.

Sl. No.	Genus Name	Total No. of Species	Distribution	Chemical Constituents *	Medicinal and/or Industrial Properties	Reference
17	<i>Coleus</i>	264	Tropics and sub-tropics of Old world	Terpinolene, α -pinene, β -pinene, β -caryophyllene, 1, 8-cineole, eugenol, carvacrol, thymol and β -phellandrene	Stimulant, antispasmodic and stomachic properties, and used for the treatment of headache, fever, epilepsy, dyspepsia, chronic cough, and asthma	[110–116]
18	<i>Calamintha</i>	9	Mediterranean region	Pulegone, menthone, isomenthone, piperitone, carvone, gallic acid, rosmarinic acid, caffeine, caffeic acid and eucalyptol	Antimicrobial, antiseptic, antispasmodic, antimicrobial, antispasmodic, sedative, and antipyretic properties.	[117,118]

* Major compounds found in most of the species of the respective genus.

3. Allelopathy of Major Lamiaceae Genera

3.1. *Salvia* (Sage)

Salvia is a well-known genus of Lamiaceae that consists of nearly 1000 species. The “*salvia* phenomenon” is one of the best-known examples of allelopathy (Tables 2 and 3). Current allelopathic research gained momentum after 1964, when a picture of *Salvia leucophylla* inhibition zones appeared on the cover page of the journal Science [119]. Muller et al. [120] reported the volatile growth inhibitors of *Salvia leucophylla* and *S. apiana*. Two years later, Muller [121] isolated the allelopathic substances of *S. leucophylla* that are responsible for its growth-suppressive properties. After Muller, many researchers investigated the allelopathic activity and allelopathic substances of the genus *Salvia* [122,123]. The crude extract, essential oils (EOs), and isolated allelochemicals of *Salvia* spp. showed growth inhibitory/stimulatory activity for the target plant species. A summary of the allelopathic activity of *Salvia* spp. reported elsewhere is presented in Tables 2 and 3. Although terpenoids are identified as the major allelopathic substances of *Salvia* spp., phenolic compounds and fatty acids (two common groups of allelochemicals) are also reported in *Salvia macrochylamis* extracts [124] (Table 3). Bisio et al. [125] identified 13 clerodane diterpenoids from *Salvia miniata* Fernald, whereas Martino et al. [126] identified 88 compounds from the essential oils of *Salvia africana* L., *Salvia greggii* A. Gray, *Salvia elegans* Vahl, *Salvia munzii* Epling, and *Salvia mellifera* Green. The amount of monoterpenoids and sesquiterpenoids are very similar in *S. africana*; while, in other species, the percentage of monoterpenoid is higher than the sesquiterpenoids. On the other hand, Nishida et al. [127] identified five volatile monoterpenoids: camphor, α -pinene, β -pinene, 1,8-cineole, and camphene from *Salvia leucophylla*, among them the volatile monoterpenoids camphor, 1,8-cineole are considered to be responsible for the “*Salvia* phenomenon” in natural settings [128].

Table 2. Allelopathic activity of Lamiaceae plant species under laboratory conditions.

Plant Species	Plant Organ	Extract Types	Target Species	Effect	Reference
<i>Salvia moorcraftiana</i> Wall.	Aerial parts	Crude acetone extract	<i>Lemna aquinoctialis</i> Welw.	Inhibited growth	[129]
<i>Salvia sclarea</i>	Aerial parts	Aqueous extract	<i>Solanum nigrum</i> L. roots	Induced lipid peroxidation	[130]

Table 2. Cont.

Plant Species	Plant Organ	Extract Types	Target Species	Effect	Reference
			<i>Bromus mollis</i> L.	Increase of the superoxide dismutase, catalase, and antioxidant enzyme activity	[131]
<i>Salvia macrosiphon</i> Boiss.	Aerial parts	Aqueous extract	<i>Zea mays</i> L.	Inhibited seed germination, growth, fresh, and dry weight of radicles and plumules	[132]
<i>Salvia macrochlamys</i> Boiss. et Kotschy	Aerial parts	Methanolic extract	<i>Portulaca oleracea</i>	Inhibited the germination, decreased the amylase activity and the abscisic acid (ABA) at higher concentrations (>2.5%), increased the gibberellic acid (GA ₃) levels at conc. <2.5%	[124]
<i>Salvia officinalis</i> L.	Aerial parts	Aqueous extracts	<i>Hordeum vulgare</i> and <i>Portulaca oleracea</i>	Inhibited germination	[133]
		Essential oils (EOs)	<i>Lectuca sativa</i>	Inhibited germination and root growth	[46]
<i>Salvia namaensis</i> Schinz, <i>Salvia fallax</i> Fernald, <i>Salvia disermas</i> L., <i>Salvia chamaedryoides</i> Cav., <i>Salvia confertiflora</i> Pohl., <i>S. × jamensis</i> J. Compton, <i>Salvia buchananii</i> Hedge, <i>S. wagneriana</i> Polak, <i>Salvia scabra</i> Linn. Fil., <i>Salvia miniata</i> Fernald, <i>Salvia cacaliaefolia</i> Benth., <i>Salvia adenophora</i> Fernald, <i>Salvia rutilans</i> Carrière	Aerial parts	Exudate	<i>Papaver rhoeas</i> L. and <i>Avena sativa</i> L.	Inhibited germination and growth	[122]
<i>Nepeta nuda</i> subsp. <i>Nuda</i>	Aerial parts	Water extracts	<i>Cucumis sativus</i> L. and <i>Triticum aestivum</i> L.	Seedling growth, fresh and dry weight	[134]
<i>Nepeta meyeri</i> Benth.	Roots and leaves	Aqueous extracts	<i>H. vulgare</i> , <i>T. aestivum</i> , <i>Brassica napus</i> L., <i>Carthamus tinctorius</i> L. and <i>Helianthus annuus</i> L.	Inhibited seed germination and seedling growth of <i>H. vulgare</i> and <i>H. annuus</i> at all concentrations. Stimulated <i>T. aestivum</i> B. <i>napus</i> and <i>C. tinctorius</i> seedling growth at lower concentrations. At higher concentration showed neutral activity to <i>T. aestivum</i> , but inhibited <i>B. napus</i> and <i>C. tinctorius</i> .	[135]
<i>Nepeta preatervisa</i>	Whole plants	Methanolic extract	<i>Lemna aquinocatalis</i>	Inhibited the development of fronds	[136]

Table 2. Cont.

Plant Species	Plant Organ	Extract Types	Target Species	Effect	Reference
<i>Ocimum basilicum</i> L.	Leaf, root and seeds	Aqueous extracts	<i>T. aestivum</i> , <i>Cicer arietinum</i> , <i>Lens culinaris</i> , <i>Brassica</i> spp., <i>Hordeum vulgare</i> , <i>Abelmoschus esculentus</i> , and <i>Pisum sativum</i>	Inhibited seed germination and seedling growth	[137]
	Aerial parts	Aqueous extract	<i>Sorghum bicolor</i> [L.] Moench, <i>Pennisetum glaucum</i> [L.] R. Br., <i>Zea mays</i> L., <i>Triticum vulgare</i> L.		[138]
		Crude methanolic extracts	<i>Lemna minor</i>	Moderate phytotoxicity (25%) was obtained at 1000 µg mL ⁻¹ concentration	[139]
		Methanol, acetone and distilled water	<i>Z. mays</i> and <i>Glycine max</i>	Root growth	[140]
		Aqueous extract	<i>Sorghum bicolor</i> [L.] Moench, <i>Pennisetum glaucum</i> [L.] R. Br., <i>Z. mays</i> and <i>Triticum vulgare</i> L.	Inhibited the seed germination of the tested cereal crops and the order of their sensitivity was <i>Z. mays</i> > <i>P. glaucum</i> > <i>T. vulgare</i> > <i>S. bicolor</i>	[141]
<i>Ocimum tenuiflorum</i> L.	Whole plants	Aqueous methanol extract	<i>Lepidium sativum</i> L., <i>Lactuca sativa</i> L., <i>Medicago sativa</i> L., <i>Lolium multiflorum</i> Lam., <i>Echinochloa crus-galli</i> L. and <i>Phleum pratense</i> L.	Inhibited the total germination percentage, germination index, germination energy, speed of emergence, seedling vigor index, coefficient of the germination rate, except those for <i>E. crusgalli</i> and germination % of <i>L. sativa</i> at higher concentration. Increased the time required for 50% germination and mean germination time.	[142]
<i>Ocimum sanctum</i> L.	Dry leaf extract	Aqueous extract	<i>Phaseolus radiata</i> (L.) Wilczek, <i>Phaseolus unguiculata</i> (L.) Walp, <i>Cajanus cajan</i> L., <i>Cicer arietinum</i> L., <i>Phaseolus mungo</i> (L.) Heeper, and <i>Phaseolus aconitifolius</i> Jacq.	No inhibition on the seed germination of the legumes, except for <i>C. arietinum</i>	[143]
	Leaf extract		<i>Amaranthus spinosus</i> L.	Inhibited seed germination (80%)	[143]
<i>Lavandula officinalis</i>	Dry leaf extract	Aqueous extract	Velvet flower and Purslane	Reduction of germination, stem and root growth, and fresh weight	[144]

Table 2. Cont.

Plant Species	Plant Organ	Extract Types	Target Species	Effect	Reference
<i>Lavandula</i> × <i>intermedia</i>	Dry flowers	Aqueous extract	<i>L. sativa</i>	Inhibited germination, seedling length, and fresh and dry weight of seedlings	[145]
<i>Lavandula</i> × <i>intermedia</i> cv. Grosso	Leaf and stem	Aqueous extract	<i>Lolium rigidum</i>	Completely inhibited root growth	[146]
<i>Lavandula</i> × <i>intermedia</i> Emeric ex Loisel.	Flowers	Aqueous extract	<i>R. sativus</i>	Completely inhibited seed germination	[147]
<i>Mentha</i> × <i>piperita</i> L.	Aerial parts	Aqueous extract	<i>R. sativus</i>	Negative effect on germination, growth, and super oxide dismutase, and positive effect on proline, soluble sugars and total phenols, ascorbate peroxidase, catalase, and peroxidase	[148]
<i>Mentha longifolia</i> syn. <i>M. sylvestris</i> L.	All parts of the plant (leaves, stem, flowers, seeds and roots)	Methanolic extract	<i>T. aestivum</i>	Inhibited shoot and root growth	[66]
<i>Mentha sylvestris</i> L.	All parts of the plant (leaves, stem and roots)	Aqueous methanolic extract	<i>Lepidum sativum</i> L., <i>L. sativa</i> L., <i>Medicago sativa</i> L., <i>B. napus</i> , <i>Phleum pretense</i> L.; <i>Digitaria sanguinalis</i> L. scop.; <i>E. crus-galli</i> , and <i>L. multiflorum</i>	Inhibited seedling growth	[149]
<i>Mentha</i> × <i>piperita</i> L.	Dry leaves	Volatile compounds	<i>R. sativus</i>	Inhibited germination	[150]
<i>Mentha longifolia</i> L.	Dry leaves	EOs	<i>Convolvulus arvensis</i> L.	Inhibited seed germination, and root and shoot growth	[151]
<i>Mentha</i> × <i>villosa</i> Huds.	Soil collected from the garden area cultivated with mint	-	<i>L. sativa</i>	Inhibited seed emergence, but had no effect on germination speed index	[152]
<i>Mentha spicata</i> L.	Foliage	EOs	<i>Alcea pallida</i> Waldst. and Kit., <i>Amaranthus retroflexus</i> L., <i>Centaurea salsotitialis</i> L., <i>R. raphanistrum</i> , <i>Rumex nepalensis</i> Spreng., <i>Sinapis arvensis</i> L., and <i>Sonchus oleraceus</i>	Inhibited seed germination	[153]
<i>Thymus serpyllum</i>	Fresh aerial parts	Methanolic extract	<i>Lemna minor</i> L. and <i>R. sativus</i>	Inhibited germination and growth	[154]

Table 2. Cont.

Plant Species	Plant Organ	Extract Types	Target Species	Effect	Reference
<i>Thymus numidicus</i> Poir.	Leaves, stem and roots	Water, petroleum ether, ethyl acetate and methano	<i>Medicago sativa</i> and <i>T. aestivum</i>	Inhibited germination and growth	[155]
<i>Thymus kotschyanus</i>	Whole plants	Aqueous extracts	<i>Bromus tomentellus</i> and <i>Trifolium repens</i>	Inhibited germination and seedling growth, and fresh and dry weight	[156]
<i>Thymus vulgaris</i>	Leaves	Aqueous extracts	<i>C. arietinum</i>	Reduced germination capability, shoot and root length, total free amino acids, and proline content. Whereas, increased the carbohydrates, proteins, K ⁺ , Ca ²⁺ , and the activity of antioxidant enzymes	[157]
<i>Thymus comosus</i> Heuff. ex Griseb. & Schenk, <i>Thymus dacicus</i> Borbás and <i>Thymus praecox</i> ssp. <i>polytrichus</i> (A. Kern. ex Borbás) Jalas	Aerial parts	Aqueous extracts	<i>R. sativus</i> and <i>B. oleracea</i>	Reduced germination percentage, speed of germination, and accumulated speed of germination	[158]
<i>Thymus vulgaris</i>	Soil under <i>Thymus</i> plants	-	<i>Daucus carota</i> , <i>Nigella damascena</i> , and <i>Bromus madritensis</i>	Reduced germination	[159]
<i>Hyptis rhomboide</i> Mart. et Gal	Stalks	Aqueous extracts	<i>B. campestris</i> , <i>R. sativus</i> and <i>O. sativa</i>	Inhibited the seed germination and seedling growth of <i>Brassica campestris</i> , <i>Raphanus sativus</i> L., <i>Oryza sativa</i>	[160]
	Leaves				
<i>Hyptis suaveolens</i> (L.) Poit.	Leaves	Leaves residue	<i>S. vulgare</i> and <i>L. sativa</i>	Reduced germination speed index and percentage of germination	[161]
		Aqueous extracts	<i>C. arietinum</i> and <i>C. cajan</i>	Fungal infections on seeds were observed after 8 days	[162]
		Leaf leachates	<i>Parthenium hysterophorus</i> , <i>Senna uniflora</i>	Inhibiting seed germination	[163]
		Leaf extracts and leachates	<i>Vigna radiata</i> cv. K851	Reduced the germination, seed viability, insoluble carbohydrates, proteins, and the activities of dehydrogenase and catalase enzymes. Increased the amino acid and soluble carbohydrate levels.	[164]
		Aqueous extracts	<i>T. aestivum</i> var k9	Reduced germination percentage, weight of germinated seeds, radicle and coleoptile length, total chlorophyll, and total proteins	[165]

Table 2. Cont.

Plant Species	Plant Organ	Extract Types	Target Species	Effect	Reference
		Ethanollic extract	<i>L. sativa</i> , <i>G. max</i>	Strong inhibitory activity was observed on the germination percentage, germination speed index, growth inhibition of seedlings and biomass production of <i>L. sativa</i>	[166]
		Aqueous extracts	<i>O. sativa</i>	Decreased the percentage of germination	[167]
<i>Hyptis suaveolens</i> (L.) Poit	Whole plants	Aqueous methanolic extracts	<i>Lepidium sativum</i> L., <i>L. sativa</i> , <i>M. sativa</i> , <i>B. napus</i> , <i>Phleum pratense</i> L., <i>Digitaria sanguinalis</i> L. Scop., <i>E. crus-galli</i> , and <i>L. multiflorum</i>	Inhibited the germination of <i>L. sativum</i> and <i>L. multiflorum</i> , and the seedling growth of all test species	[78]
<i>Hyptis suaveolens</i> (L.)	Leaves and roots	Aqueous extracts	<i>O. sativa</i> cv. <i>Gobindobhog</i>	Inhibited germination, shoot and root length	[168]
<i>Leucas aspera</i> (Willd.) Linn.	Whole plants	Aqueous methanolic extracts	<i>L. sativum</i> L., <i>L. sativa</i> , <i>M. sativa</i> , <i>P. pratense</i> , <i>E. colonum</i> , <i>E. crus-galli</i> , and <i>L. multiflorum</i>	Inhibited the seedling growth of all test species	[169]
<i>Leucas cephalotes</i> (Roth)	Leaves and roots	Aqueous extracts	<i>O. sativa</i> cv. <i>Gobindobhog</i>	Inhibited germination, shoot and root length	[168]
<i>Leonurus sibiricus</i> L.	Aerial parts	Aqueous extracts	<i>T. aestivum</i>	Inhibited seed germination and seedling growth	[170]
	Whole plants	Aqueous methanolic extracts	<i>L. multiflorum</i> , <i>L. sativum</i> , and <i>L. sativa</i>	Inhibited seed germination	[171]
			<i>L. multiflorum</i> , <i>L. sativum</i> , <i>L. sativa</i> , <i>P. pratense</i> , <i>D. sanguinalis</i> , <i>M. sativa</i> , and <i>B. napus</i>	Inhibited seedling growth	
	Aerial parts	Aqueous, ethanol, and acetone extracts	<i>Solanum melongena</i> , <i>Abelmoschus esculentus</i> , <i>Amaranthus tricolor</i> and <i>Cucumber Cucumis sativus</i>	Inhibited seed germination and seedling growth	[172]
<i>Hyssopus officinalis</i> L.	Aerial parts	Water infusions	<i>Cucumis sativus</i> L. and <i>T. aestivum</i>	Inhibitory effects on germination and root elongation (<i>T. aestivum</i> > <i>C. sativus</i>)	[173]
			<i>Allium cepa</i> L.	Mitodepressive and genotoxic effect on the root tip cells	
<i>Origanum vulgare</i> ssp. <i>hirtum</i> (Link)	-	EOs	<i>Arabidopsis seedlings</i>	Inhibited glutamate and aspartate metabolism, altering the photorespiratory pathway	[174]

Table 2. Cont.

Plant Species	Plant Organ	Extract Types	Target Species	Effect	Reference
<i>Origanum onites</i> L.	-	EOs	<i>T. aestivum</i> , <i>Avena Sterilis</i> and <i>Sinapis arvensis</i>	Inhibited germination and seedling length	[37]
	-	Volatile oils	<i>Onobrychis viciifolia</i>	Reduced plant length	[175]
<i>Origanum vulgare</i> ssp. <i>vulgare</i> L.	Aerial parts	Cold water extracts	<i>T. aestivum</i>	Decreased root length	[176]
			<i>Allium cepa</i> L.	Inhibited cell division in root meristematic cells, induced abnormalities in mitotic and interphase cells	
			<i>Cucumis sativus</i> L.	Decreased root length	[177]
<i>Origanum majorana</i> L.	Seed, aerial parts	Co-germination, Aqueous extracts	<i>Z. mays</i>	Co-germination stimulated <i>Z. mays</i> germination, whereas aqueous extracts inhibited root length	[178]
<i>Origanum compactum</i> Benth.	Leaves	Aqueous extracts	<i>Microcystis aeruginosa</i>	Inhibited the growth and decreased the photosynthetic pigments (chlorophyll-a and carotenoids)	[179]
<i>Rosmarinus officinalis</i> L.	Dry plant powder	EOs	<i>M. aeruginosa</i> and <i>Chroococcus minor</i>	Decreased growth rates	[180]
	Aerial parts	EOs	<i>L. sativa</i> , <i>A. retroflexus</i> , <i>P. oleracea</i> , and <i>Acroptilon repens</i>	Inhibited seed germination and growth	[181]
	Aerial parts (inflorescences, leaves and stems)	Solid residue	<i>Lycopersicon esculentum</i> L. and <i>Lolium perenne</i> L.	Limited phytotoxic effects on germination, root and leaf growth	[182]
	Leaves	Aqueous extracts	<i>Panicum turgidum</i> Forssk.	Inhibited germination percentage, relative germination percentage, plumule and radicle lengths	[183]
	Aerial parts	EOs	<i>Cynodon dactylon</i> L., <i>Festuca arundinacea</i> Schreb. and <i>Lolium perenne</i> L.	Inhibited seed germination and growth	[184]
<i>Satureja montana</i> L.	Aerial parts	Aqueous extracts	<i>Capsicum annuum</i> L. and <i>Solanum nigrum</i> L.	Not phytotoxic, induced lipid peroxidation in <i>S. nigrum</i> roots, and increased the pyrogallol and guaiacol peroxidase in <i>S. nigrum</i> leaves	[185]
<i>Satureja thymbra</i> L.	Aerial parts	Aqueous extracts	<i>Pinus halepensis</i> Mill. and <i>Ceratonia siliqua</i> L.	Inhibited the germination of <i>C. siliqua</i> , and the root length and number of leaves of <i>P. halepensis</i> and <i>C. siliqua</i>	[186]
<i>Satureja montana</i> L.	Aerial parts	Aqueous extracts	<i>Datura stramonium</i> L.	Induced lipid peroxidation in roots of <i>D. stramonium</i>	[187]

Table 2. Cont.

Plant Species	Plant Organ	Extract Types	Target Species	Effect	Reference
			<i>G. max</i>	Increase in the catalase and superoxide dismutase activity of roots, and the superoxide dismutase activity in leaves	[188]
<i>Satureja khuzestanica</i> Jamzad, <i>S. bachtiarica</i> Bunge and <i>S. rechingeri</i> Jamzad	Aerial parts	Aqueous extracts	<i>L. sativum</i> , <i>Solanum lycopersicum</i> , and <i>Secale cereale</i>	<i>S. khuzestanica</i> aqueous extract was most suppressive to <i>S. cereale</i> seed germination, while <i>S. bachtiarica</i> aqueous extract suppressed the germination and growth indices of <i>L. sativum</i> , <i>Solanum lycopersicum</i> and seedlings	[189]
	Leaves	Dry leaves powder		<i>S. rechingeri</i> had the maximum inhibitory effect on germination percent and growth indices of <i>S. cereale</i> , <i>L. sativum</i> and <i>Solanum lycopersicum</i>	
<i>Satureja hortensis</i> L.	Aerial parts	Aqueous extracts	<i>P. oleraceae</i> and <i>Chenopodium album</i>	Inhibited the root, stem, leaf growth, root/shoot ratio, germination rate, and percentage germination	[190]
<i>Tectona grandis</i> L.	Green and deciduous leaves	Methanol extract	<i>E. colona</i> , <i>Cyperus difformis</i> L. and <i>O. sativa</i>	Inhibitory activity on <i>E. colona</i> germination, no activity on <i>O. sativa</i>	[191]
		Aqueous extracts		Inhibitory activity on <i>C. difformis</i> germination, no activity on <i>O. sativa</i>	
	Dried leaves	Aqueous extracts	<i>Vigna mungo</i> var. ADT-3 and <i>V. radiata</i> var. Co-3	Completely inhibited the seedling growth, dry weight at 100% concentration	[192–194]
	Fresh leaves	Aqueous extracts	<i>Plumbago zeylanica</i> Linn.	Inhibited the seed germination and seedling growth	[195]
	Leaves and flowers	Aqueous extracts	<i>L. sativa</i>	No inhibitory potential on the percentage and average germination time	[196]
	Leaves	Leachates	<i>Vigna unguiculata</i> , <i>Momordica charantia</i> and <i>Solanum melongena</i> L.	Inhibited the seed germination and seedling growth	[197]
	Leaves	Aqueous extracts	<i>Vigna mungo</i> (L.) Hepper	Inhibited the seed germination and seedling growth	[198]
	Top soil	Aqueous extracts	<i>L. esculentum</i>	Suppressed germination and growth	[199]
<i>Orthosiphon stamineus</i> Benth. (syn. <i>O. aristatus</i> , <i>O. gradiflorus</i> , <i>O. spicatus</i>)	Shoots	Aqueous methanol extracts	<i>L. sativum</i> and <i>L. sativa</i>	Inhibited root and hypocotyl growth	[200]

Table 2. Cont.

Plant Species	Plant Organ	Extract Types	Target Species	Effect	Reference
<i>Calamintha nepeta</i> L. (Savi)	Leaves and stems	Methanol extract was further fractionated using n-hexane, chloroform, ethyl acetate and n-butanol	<i>L. sativa</i>	Inhibited germination and root growth of <i>L. sativa</i> with a methanolic extract and also with its fraction. Hierarchy of phytotoxicity of its fraction was ethyl acetate > n-hexane > chloroform > n-butanol	[29]
	Foliar	Volatiles and EOs	<i>L. sativa</i> , <i>R. sativus</i> and <i>A. retroflexus</i>	Volatiles strongly inhibited both germination and root growth of <i>L. sativa</i> , and EOs at >125 $\mu\text{L L}^{-1}$ inhibited both processes of <i>L. sativa</i> , <i>R. sativus</i> , <i>A. retroflexus</i>	[201]
	Leaves and green stem	Aqueous extract	<i>L. sativa</i> , <i>C. album</i> , <i>Sinapis alba</i> ,	Inhibited germination and root growth	[202]
<i>Coleus amboinicus</i> L.	Dried leaves powder	Aqueous extract	<i>Eichhornia crassipes</i> Mart.	Reduced the fresh and dry weight	[203,204]
<i>Coleus forskohli</i>	Leaves	Aqueous extract	<i>T. aestivum</i>	Root–shoot length and dry weight	[205]

Table 3. Allelochemicals isolated from Lamiaceae plant species and their allelopathic potential.

Plant Species	Allelochemical/ Major Compounds	Parts from Where Isolated	Target Species	Effect	Reference
<i>Salvia miniata</i> Fernald	13 clerodane diterpenoids	Extracts of aerial parts	<i>Papaver rhoas</i> L. and <i>Avena sativa</i> L.	Inhibited germination and growth	[125]
<i>Salvia elegans</i> Vahl, <i>Salvia greggii</i> A. Gray, <i>Salvia munzii</i> Epling	monoterpenoids and sesquiterpenoids	Essential oils (EOs)	<i>R. sativus</i> . and <i>L. sativum</i>	Inhibited germination and root growth	[126]
<i>Salvia leucophylla</i>	volatile monoterpenoids (camphor, 1,8-cineole, β -pinene, α -pinene, and camphene)	Volatile compounds from seeds	<i>B. campestris</i>	All five monoterpenoids inhibited root growth but camphor, 1,8-cineole, and β -pinene only inhibited germination at high concentrations	[127]
<i>Salvia miltiorrhiza</i>	neo-przewaquinone A	Roots	<i>M. aeruginosa</i>	Caused cell morphologic damage or lysis, increased malondialdehyde content, and decreased the soluble protein content, total antioxidant, and superoxide dismutase activity, and significantly inhibited three photosynthesis-related genes (psaB, psbD, and rbcL)	[206]
<i>Salvia broussonetii</i>	demethylsalvicanol and 14-deoxycoleon U	Roots	<i>Leptinotarsa decemlineata</i>	Antifeedant	[207]
	demethylcryptojaponol			Toxic	
<i>Nepeta faassenii</i>	2-(2-ethoxyethoxy)ethanol, alloaromadendrene, and X-cadinene	Volatile mixture and the methanolic extract, but also in an aqueous foliar extract	<i>L. sativum</i>	Growth	[208]

Table 3. Cont.

Plant Species	Allelochemical/ Major Compounds	Parts from Where Isolated	Target Species	Effect	Reference
<i>Nepeta meyeri</i> Benth.	4 α ,7 α ,7 β -nepetalactone (83.4%)	EOs	<i>A. retroflexus</i> , <i>Bromus danthoniae</i> Trin., <i>Bromus intermedius</i> Guss., <i>L. serriola</i> , <i>C. album</i> , <i>C. dactylon</i>	Inhibited germination and seedling growth. Increased CAT activity in all the weed species, and decreased SOD activity, except in <i>A. retroflexus</i> . Also increased the lipid peroxidation and hydrogen peroxide (H ₂ O ₂) concentration	[209,210]
	4 α ,7 α ,7 β -nepetalactone (80.3% in essential oils), 4 α ,7 α ,7 β -nepetalactone (83.7% in hexane extract)	Aerial parts	<i>A. retroflexus</i> , <i>C. album</i> , <i>Cirsium arvense</i> L. and <i>Sinapsis arvensis</i> L.	The essential oils completely inhibited the germination of all species. Concentration-dependent inhibitory activity by the extract.	[35]
<i>Nepeta curviflora</i> Boiss., <i>Nepeta nuda</i> L. subsp. <i>albiflora</i> (Boiss.) Gams., <i>Nepeta nuda</i> L. subsp. <i>albiflora</i>	Aerial parts	EOs	<i>R. sativus</i> and <i>L. sativum</i>	Germination and initial radical elongation	[211]
<i>Calamintha nepeta</i> (L.) Savi	-	Foliar volatiles	<i>L. sativa</i>	Inhibited both germination and root growth	[29]
	pulegone	EOs	<i>L. sativa</i> , <i>R. sativus</i> and <i>A. retroflexus</i>		
<i>Nepeta meyeri</i> Benth.	4 α ,7 α ,7 β -nepetalactone (80.4% in essential oils),	Aerial parts & EOs	<i>Bromus danthoniae</i> , <i>L. serriola</i> , <i>B. napus</i> and <i>Z. mays</i>	Inhibited the germination	[212]
<i>Nepeta flavida</i>	linalool (37.64%) and 1,8-cineole (30.80%)	Aerial parts EOs	<i>L. sativum</i> , <i>R. sativus</i> and <i>Eruca sativa</i>	Completely inhibited the germination at 4.0 and 8.0 μ L mL ⁻¹	[213]
<i>Nepeta pannonica</i> L.	1,8-cineole (28.9%), and 4 α ,7 β ,7 α -nepetalactone (14.3%)	Aerial parts EOs	<i>Agrostis stolonifera</i> cv. <i>Pencross</i>	100% growth inhibition at 0.3 mg mL ⁻¹	[214]
			<i>L. sativa</i> cv. <i>Iceberg</i>	100% growth inhibition at 1.0 mg mL ⁻¹	
<i>Ocimum americanum</i>	limonene, camphor and linalol	EOs	<i>Mimosa pudica</i> and <i>Senna obtusifolia</i>	Inhibited the germination and seedling growth	[215]
<i>Ocimum gratissimum</i>	flavonoids	Dried powdered leaves	Bean and <i>Z. mays</i> seedlings	Inhibited the radicles more than their coleoptiles	[216]
<i>Lavandula angustifolia</i> Mill.	lavandulol, terpinen-4-ol, linalyl acetate, lavandulyl acetate and α -terpineol	EOs	<i>Setaria verticillata</i> (L.) P. Beauv.	Inhibited germination and root length	[217]
<i>Lavandula</i> \times <i>hybrida</i> Rev.	linalool (27.51%) and linalyl acetate (37.21%)	EOs	Crops: <i>T. aestivum</i> and <i>H. vulgare</i> and Weeds: <i>Lolium rigidum</i> L. and <i>Phalaris brachystachys</i> L.	Inhibited the germination and root length of weeds and had no effect on crops	[218]
<i>Lavandula</i> \times <i>intermedia</i> cv. <i>Grosso</i>	coumarin and 7-methoxycoumarin	Leaf and stem extract	<i>L. rigidum</i>	Inhibited growth	[146]
<i>Lavandula stoechas</i>	stoechanones A and B	Aqueous methanol extract	<i>A. retroflexus</i>	Inhibited the seed germination percentage, radicle, and hypocotyl lengths	[219]

Table 3. Cont.

Plant Species	Allelochemical/ Major Compounds	Parts from Where Isolated	Target Species	Effect	Reference
<i>Mentha longifolia</i> (L.) Huds.	piperitone oxide (53.83%) and piperitenone oxide (11.52%), followed by thymol (5.80%), and (<i>E</i>)-caryophyllene (4.88%)	EOs	<i>C. rotundus</i> , <i>E.</i> <i>crus-galli</i> and <i>O. sativa</i>	In a pre-emergence assay: Inhibiting percent germination, plantlet growth, and chlorophyll content of the weeds. In pre-emergence assay: loss of chlorophyll, wilting, and growth inhibition, leading to death of all species	[220]
			<i>Allium cepa</i> L. root tips.	EO exposure to the onion roots induced various chromosomal aberrations	
<i>Mentha spicata</i> L.	carvone (15.3–68.5%), piperitenone oxide (24.0–79.2%) and α -humulene (0.1–29.9%)	EOs	<i>S. tuberosum</i>	Sprout suppressant	[221]
<i>Mentha</i> \times <i>piperita</i> L.	(-)-menthol (58.7–71.2%), menthone (3.5–19.6%), limonene (3.4–8.4%), menthyl acetate (1.4–17.2%) and β -caryophyllene (2.4–6.3%)	EOs	<i>R. sativus</i>	Stimulated the germination	[222]
<i>Mentha pulegium</i> L.	pulegone (57.8–62.8%), menthone (9.5–15.0%) and limonene (4.9–6.9%)	EOs	<i>M. sativa</i>	Inhibited the germination	[223]
<i>Mentha spicata</i> L., <i>M.</i> <i>crispa</i> , <i>M. longifolia</i> ,	menthone/isomenthone	EOs	<i>L. sativum</i>	Inhibited the germination	[224]
<i>Mentha</i> \times <i>piperita</i> L. cv. Mitcham	menthol (35%), mentone (17.48%), menthofuran (11.7%) and 1,8-cineole (5.9%)	EOs	<i>L. esculentum</i> , <i>R.</i> <i>sativus</i> , <i>Convolvulus</i> <i>arvensis</i> L., <i>P.</i> <i>oleracea</i> and <i>E. colonum</i>	Inhibited germination percentage, root and shoot lengths, and dry weight of the seedlings. Crops were more susceptible than weeds.	[225]
	<i>trans</i> -ferulic acid (10.8 mg/g), hesperidin (9.3 mg g ⁻¹), ellagic acid (6.8 mg g ⁻¹) and sinapic acid (4.2 mg g ⁻¹)	Aqueous extract			
<i>Mentha</i> \times <i>piperita</i> L. cv. Mitcham	<i>trans</i> -ferulic acid (10.8 mg g ⁻¹), hesperidin (9.3 mg g ⁻¹), ellagic acid (6.8 mg g ⁻¹) and sinapic acid (4.2 mg g ⁻¹)	Aqueous extract	<i>R. sativus</i>	Inhibited germination and growth, total chlorophyll content. Stimulated proline, soluble sugar, phenolic compound content	[148]
<i>Mentha</i> \times <i>piperita</i>	pulegone and menthone	EOs	Cucumber	Root and mitochondrial respiration	[226]
<i>Thymus algeriensis</i> Boiss. et Reut.	α -pinene (19.5%), 1,8-cineole (11.6%) and camphor (10.4%)	EOs	<i>M. sativa</i> and <i>T. aestivum</i>	Inhibited shoot and root growth	[227]
<i>Thymus fontanesii</i> Boiss. et Reut.	carvacrol (52.1%), thymol (13.3%), <i>p</i> -cymene (12.2%) and γ -terpinene (8.1%)	EOs	<i>S. arvensis</i> , <i>Avena</i> <i>fatua</i> L., <i>Sonchus</i> <i>oleraceus</i> L., <i>Xanthium</i> <i>strumarium</i> L. and <i>C. rotundus</i>	Inhibited germination percentage	[28]
<i>Thymus capitatus</i> Hoff. et Link	carvacrol (63–84%)	EOs	<i>S. arvensis</i>	Inhibited germination	[228]

Table 3. Cont.

Plant Species	Allelochemical/ Major Compounds	Parts from Where Isolated	Target Species	Effect	Reference
<i>Thymus capitatus</i> L.	carvacrol (75.30%)	EOs	Crops: <i>T. aestivum</i> and <i>H. vulgare</i> Weeds: <i>L. rigidum</i> and <i>P. brachystachys</i>	Almost no effect on crop's germination but caused radical length inhibition. However, both germination and radical length of weeds were inhibited	[218]
<i>Thymus daenensis</i> Celak.	thymol (20–60.5%) and carvacrol (20.1–63.4%)	EOs	<i>A. retroflexus</i> , <i>Avena fatua</i> , <i>Datura stramonium</i> and <i>L. sativum</i>	Inhibited germination	[229]
<i>Thymus decussatus</i>	carvacrol (75.91–94.40%)	EOs	<i>L. sativa</i>	Inhibited seed germination, shoot, and root growth	[230]
<i>Thymus capitatus</i>	carvacrol (68.19%)	EOs	<i>L. sativa</i>	Inhibited seed germination	[231]
<i>Thymus eigii</i>	thymol (24.77%) and carvacrol (14.0%)	EOs	<i>L. sativa</i> , <i>L. sativum</i> and <i>P. oleracea</i>	Inhibited germination and growth	[232]
<i>Thymus vulgaris</i> L.	thymol (35.4%), <i>p</i> -cymene (34.7%)	EOs	<i>P. oleracea</i> , <i>Vicia sativa</i> L.	Inhibited seed germination	[233]
<i>Thymus capitatus</i> L., <i>Thymus vulgaris</i> L.	<i>T. capitatus</i> : thymol (15.17%) and carvacrol (53.16%) <i>T. vulgaris</i> : thymol (12.74%) and carvacrol (48.23%)	EOs	<i>L. sativum</i>	Inhibited germination parameters (germination percentage, time to get 50% germination, mean germination time, germination index), hypocotyl, and radicle length	[234]
<i>Hyptis suaveolens</i> Poit.	14 α -hydroxy-13 β -abiet-8-en-18-oic acid (suaveolic acid)	Aqueous methanol extract	<i>L. sativum</i> , <i>L. multiflorum</i> and <i>E. crus-galli</i>	Inhibited seedling growth	[32]
<i>Leucas aspera</i> (Willd.) Linn.	3:2 mixture of two labdane type diterpenes (rel 5 <i>S</i> ,6 <i>R</i> ,8 <i>R</i> ,9 <i>R</i> ,10 <i>S</i> ,13 <i>S</i> ,15 <i>S</i> ,16 <i>R</i>)-6-acetoxy-9,13;15,16-diepoxy-15-hydroxy-16-methoxylabdane and (rel 5 <i>S</i> ,6 <i>R</i> ,8 <i>R</i> ,9 <i>R</i> ,10 <i>S</i> ,13 <i>S</i> ,15 <i>R</i> ,16 <i>R</i>)-6-acetoxy-9,13;15,16-diepoxy-15-hydroxy-16-methoxylabdane (2)	Aqueous methanol extract	<i>L. sativum</i> and <i>E. crus-galli</i>	Inhibited germination and seedling growth	[30]
<i>Leonurus sibiricus</i> L.	caffeic acid	Root exudates	<i>O. sativa</i> , <i>T. aestivum</i> and <i>B. spp.</i>	Inhibited germination and seedling growth	[235]
<i>Leonurus sibiricus</i> L.	3'-OH-genkwanin and quercetin	Methanol extract	<i>L. sativa</i>	Inhibited germination	[236]
	3'-OH-genkwanin, rutin, and isoquercetrin			Inhibited radicle growth	
<i>Origanum syriacum</i>	carvacrol (60.1%), <i>p</i> -Cymene (19.7%), γ -Terpinene (13%)	EOs	<i>T. aestivum</i> and <i>Amaranthus</i>	Inhibited germination	[237]
<i>Origanum vulgare</i> ssp. <i>vulgare</i> L.	caryophyllene oxide (34.44%), β -caryophyllene (20.40%) and α -cadinol (7.02%)	EOs	<i>Z. mays</i>	DNA alterations	[238]
<i>Origanum acutidens</i>	carvacrol (87.0%)	EOs	<i>A. ret-roflexus</i> , <i>C. album</i> , and <i>Rumex crispus</i>	Inhibited seed germination and seedling growth	[86]

Table 3. Cont.

Plant Species	Allelochemical/ Major Compounds	Parts from Where Isolated	Target Species	Effect	Reference
<i>Origanum onites</i> L.	carvacrol (91.39%)	EOs	Crops: <i>T. aestivum</i> cv Gün 91, <i>H. annuus</i> cv. Sirena and <i>C. arietinum</i> Weeds: <i>A. retroflexus</i> , <i>Rumex crispus</i> L. and <i>S. arvensis</i>	Reduced germination rate of weeds but had no effect on crops	[239]
<i>Origanum vulgare</i> L.	carvacrol (34.0%) and γ -terpinene (21.6%), <i>p</i> -cymene (9.4%)	EOs	<i>S. arvensis</i>	Inhibited seed germination and seedling growth	[240]
<i>Origanum vulgare</i> L.	methyleugenol (16.5%), myristicin (15.6%), carvacrol (15.0%), thymol (9.8%), and apioline (9.4%)	EOs	<i>T. aestivum</i> , <i>V. radiata</i> and <i>R. sativus</i>	Inhibited seed germination and seedling growth	[241]
<i>Origanum vulgare</i> ssp. <i>hirtum</i>	thymol and carvacrol (65.3–84.7%)	EOs	<i>S. arvensis</i> L., <i>P. canariensis</i> , <i>L. sativum</i> L., and <i>R. sativus</i> L.	Inhibited seed germination and seedling growth	[242]
<i>Origanum onites</i> L.	carvacrol (59.87%), γ -terpinene (17.08%) and β -cymene (8.83%)	EOs	<i>A. retroflexus</i> L., <i>T. aestivum</i> L. and <i>L. sativum</i> L.	Completely inhibited seed germination, and root and shoot growth	[243]
<i>Rosmarinus officinalis</i> L.	α -pinene (29.6%), 1,8-cineole (25.6%) and piperitone (14.1%)	Fresh leaves leachate	<i>Eleusine indica</i> (L.) Gaertn., <i>C. dactylon</i> , <i>D. sanguinalis</i>	Inhibited seed germination and seedling growth	[89]
	α -pinene (25.7%), 1,8-cineole (13.2%) and piperitone (20.5%)	Stem			
	α -pinene (33.7%), 1,8-cineole (19.4%) and piperitone (30.4%)	Root			
	α -pinene (44.3%), 1,8-cineole (26.7%) and piperitone (6.5%)	Litter			
	α -pinene, 1,8-cineole, camphor	Aerial parts	<i>A. retroflexus</i> , and <i>Lolium perenne</i>	Inhibited germination, early growth, and physiological and histological parameters	[39]
	α -pinene (25.8–27.7%), camphor (8.6–9%), camphene (6.5–7.7%) and 1,8-cineole (9.4–9.6%)		<i>L. serriola</i> and <i>R. sativus</i>	Inhibited seed germination and growth	[36]
	α -pinene (24.9%), verbenol (8.5%), verbenone (8.5%), 1,8-cineol (8.2%) and isoborneol (8.1%)		<i>Ruta graveolens</i> L.	Increased radical elongation at higher concentration (100 $\mu\text{g mL}^{-1}$)	[90]
		<i>R. sativus</i>	Inhibited radical elongation at higher concentrations (100 $\mu\text{g mL}^{-1}$)		
		<i>L. sativa</i>	Inhibited radical elongation		
		<i>S. lycopersicum</i>	Inhibited germination only		
<i>Satureja hortensis</i> L.	carvacrol (46.94%) and γ -terpinene (29.14%)	Aerial parts	<i>L. rigidum</i> L. and <i>P. brachystachys</i> L.	Inhibited the germination and root length of <i>L. rigidum</i> and <i>P. brachystachys</i>	[218]

Table 3. Cont.

Plant Species	Allelochemical/ Major Compounds	Parts from Where Isolated	Target Species	Effect	Reference
<i>Satureja</i> spp., <i>S. khuzestanica</i> , <i>S. bachtiarica</i> , <i>S. rechingeri</i> and <i>S. spicigera</i>	carvacrol and thymol	EOs	<i>L. esculentum</i> and <i>S. cereale</i>	<i>S. khuzestanica</i> and <i>S. rechingeri</i> essential oils showed high inhibitory effect against <i>L. esculentum</i> and <i>S. cereale</i> , whereas <i>S. bachtiarica</i> showed the least. <i>S. spicigera</i> and <i>S. rechingeri</i> inhibited the germination and growth of <i>S. cereale</i>	[107]
<i>Satureja hortensis</i> L.	carvacrol (55.6%) and γ -terpinene (31.9%)	EOs nanoemulsion	<i>A. retroflexus</i> and <i>C. album</i>	Inhibited the germination, shoot-root growth, and chlorophyll content	[244]
<i>Tectona grandis</i>	2-oxokovalenic acid and 19-hydroxyferruginol	Aqueous extract dried leaves	<i>T. aestivum</i>	Inhibited the elongation of etiolated wheat coleoptiles	[245]
<i>Orthosiphon stamineus</i> Benth. (syn. <i>O. aristatus</i> , <i>O. gradiflorus</i> , <i>O. spicatus</i>)	13-epi-Orthosiphon N	Shoots	<i>L. sativum</i> and <i>L. sativa</i>	Inhibited root and hypocotyl growth	[200]
<i>Calamintha nepeta</i> L. (Savi)	gallic, vanillic, syringic, <i>p</i> -coumaric and ferulic acids from ethylacetate fraction <i>trans</i> -caryophyllene, menthol, farnesene and pulegone from <i>n</i> -hexane	Methanol extract of leaves and stem	<i>A. retroflexus</i> and <i>E. crus-galli</i>	Inhibited seed germination and root growth	[29]
	Four terpenoids, camphor, pulegone, <i>trans</i> -caryophyllene and farnesene	Methanolic extract and EOs	<i>Arabidopsis thaliana</i> (L.) Heynh	Farnesene and <i>trans</i> -caryophyllene had a strong inhibitory effect on root growth, and pulegone at the highest concentrations reduced lateral root formation. The addition, at low concentration, of farnesene to pulegone–camphor– <i>trans</i> -caryophyllene mixture further increased the inhibitory effect on root elongation	[201]
<i>Calamintha ashei</i>	Saturated aqueous solutions of menthofuran, (+)-evodone, (-)-calaminthone, (+)-desacetylcaminthone, 4 α ,5 β –diacetoxymenthofuran, and a mixture of (+)-evodone and (+)-desacetylcaminthone	Fresh aerial parts	<i>Schizachyrium scoparium</i> and <i>Leptochloa dubia</i> and <i>L. sativa</i>	Inhibited germination and root growth	[246]

Salvia extracts have insecticidal, antimicrobial, and antifungal activities. For example, a crude acetone extract of the aerial parts of *Salvia moorcraftiana* Wall. had moderate antifungal activity against animal and plant pathogens [129]. *Salvia sclarea* aqueous extract had a toxic effect on *Trialeurodes vaporariorum* (whitefly) with 57% mortality [130]. Zhang et al. [206] isolated and identified neo-przewaquinone A (a potent algicidal compound) from *Salvia miltiorrhiza* extract and reported this compound caused morphologic damage or lysis to cells, increased malondialdehyde content, and decreased the soluble protein content, total antioxidant, and superoxide dismutase activity; and significantly inhibited three photosynthesis-related genes (*psaB*, *psbD*, and *rbcL*) of *Microcystis aeruginosa*. On the other hand, Fraga et al. [207] identified demethylsalvicanol, 14-deoxycoleon U, demethyl-cryptojaponol, and a few other compounds from the roots of *Salvia broussonetii*. Among

them, demethylsalvicanol and 14-deoxycoleon U were moderate and strong antifeedants to *Leptinotarsa decemlineata*, respectively, while demethylcryptojaponol was toxic to this insect.

3.2. *Nepeta*

The plant species of the genus *Nepeta* are generally known as “Catnip” or “Catmint”. The genus comprises more than 250 species. Although the species of this genus are usually distributed in North America, Europe, Asia, and Africa, the greatest species diversity is found in Asia (111 species) [53]. The extracts and essential oils of various *Nepeta* species have a wide spectrum of biological activities (Table 1). Mutlu et al. [209] published an image of the inhibition zone of *Nepeta meyeri* that did not allow the germination of other wild plant species in natural settings. Several researchers around the globe also reported the allelopathic activity of *Nepeta* spp. and identified the allelopathic substances responsible for their phytotoxic activity (Tables 2 and 3).

The EOs from the aerial parts of *Nepeta cataria* L. showed phytotoxic activity to three noxious weeds (*Hordeum spontaneum* Koch, *Avena fatua* L., and *Taraxacum officinale*) and tree crops (*Lepidium sativum*, *Ocimum basilicum*, and *Nepeta cataria*) species, at different inhibition levels [247]. For example, with a concentration of 1200 $\mu\text{L L}^{-1}$, 100% inhibition of seed germinations (complete inhibition) of all test species except in *H. spontaneum* were observed. At this concentration, 26% seed germination of *H. spontaneum* was observed. In addition, the germination percentages of *A. fatua* and *T. officinale* at 600 $\mu\text{L L}^{-1}$ and *L. sativum* and *O. basilicum* at 1200 $\mu\text{L L}^{-1}$ were completely inhibited (100%) [247]. Eom et al. [208] reported that the volatiles of *N. × faassenii* fresh foliage and its aqueous and methanol extracts significantly inhibited the seedling growth of curly cress (*Lepidium sativum*). They observed that *N. × faassenii* volatiles inhibited shoot and root growth by 48% and 44%, respectively, at 10 g of foliage, whereas the root and shoot growth of *L. sativum* was completely inhibited with the 20 g foliage treatment. On the other hand, aqueous extracts of *N. × faassenii* showed higher inhibition compared to methanolic extracts when similar dosages of extracts were applied. Complete (100%) inhibition on the germination of *L. sativum* was observed when exposed to concentrations of 0.5 mg mL^{-1} or more aqueous extracts and 1.0 mg mL^{-1} methanolic extracts, respectively. Furthermore, the aqueous foliage extracts exhibited greater activity in seedling growth reduction on a per-weight basis than methanolic extracts. Three phytotoxic compounds responsible for *N. × faassenii* phytotoxic activity: 2-(2-ethoxyethoxy)ethanol, alloaromadendrene, and *x*-cadinene, were isolated from the volatile mixture, methanolic extract, and the aqueous foliar extract [208].

Mutlu and Atici [135] observed that the roots and leaves extracts of *Nepeta meyeri* Benth. showed an allelopathic effect on the germination and seedling growth of barley and sunflower. On the other hand, both extracts significantly increased the seedling growth of canola, wheat, and safflower, especially at the lower concentrations (up to 0.5% of the extract). Interestingly, a neutral effect was found at higher concentrations only in wheat and being phytotoxic to other species. Their findings reported that the allelopathic activity of *N. meyeri* depends on the source of the plant extract (leaf or root), and the highest inhibitory activity was observed with leaf extracts. Mutlu et al. [209] identified a strong oxygenated monoterpene; 4 α ,7 α ,7 β -nepetalactone from the EOs of *Nepeta meyeri* Benth. aerial parts, as a major compound responsible for their phytotoxicity. This monoterpene showed concentration-dependent inhibitory activity on the germination and growth of weed species, including *Amaranthus retroflexus* L., *Bromus intermedius* Guss., *Bromus danthoniae* Trin., *Cynodon dactylon* L., *Chenopodium album* L., and *Lactuca serriola* L. Kordali et al. [35], on the other hand, evaluated the phytotoxic activities of the essential oil, n-hexane, chloroform, acetone, and methanol extracts of the aerial parts and roots of *N. meyeri* Benth. against the germination and growth of four weed species: *A. retroflexus*, *C. album*, *Cirsium arvense* L., and *Sinapsis arvensis* L. The essential oil of *N. meyeri* completely inhibited the germination of all weed seeds, although the extracts showed a wide variation in their inhibition of the seedling growth of the weed species. The extracts and EOs also showed phytotoxicity against these weeds. The acetone extract was the most effective

compared to the other extracts. The mortality percentage ranged from 22–66% (48 h after application). Finally, Kordali et al. [35] isolated the main compound from the EOs and n-hexane extract, and reported 4 α ,7 α ,7 β -nepetalactone (>80%) as the main allelopathic compound responsible for the phytotoxic activity of *N. meyeri*. The genotoxic activity of 4 α ,7 α ,7 β -nepetalactone isolated from the EOs of the aerial parts of *N. meyeri* was also reported against the weeds, *Bromus danthoniae* and *Lactuca serriola*; and crops, *Brassica napus* and *Zea mays* [212].

The EOs of *Nepeta curviflora* Boiss. contained β -caryophyllene, caryophyllene oxide, (*E*)- β -farnesene, and (*Z*)- β -farnesene; *Nepeta nuda* L. subsp. *albiflora* (Boiss.) Gams. contained β -bisabolene, pulegone, (*E,Z*)-nepetalactone, (*E*)- β -farnesene, and caryophyllene oxide, while *Nepeta nuda* L. subsp. *albiflora* (collected from different areas) contained hexadecanoic acid, β -bisabolene, caryophyllene oxide, pulegone, and (*E,Z*) nepetalactone. All these EOs showed phytotoxic activity on the germination and initial root growth of *Lepidium sativum* L. and *Raphanus sativus* L. [211]. Formisano et al. [248] isolated 75 compounds, which comprised 96.8% of the total EOs; where spathulenol (15.1%), hexadecanoic acid (14%), δ -cadinene (5.5%), and α -copaene (4.5%) were the main compounds. In addition, the oil was constituted mainly by sesquiterpenes (45.9%), among which 27.6% was sesquiterpene hydrocarbons and 18.3% was oxygenated sesquiterpenes. Bozok [213], on the other hand, isolated 41 compounds from the EOs of the aerial parts of *Nepeta flavida*, where linalool (37.6%) and 1,8-cineole (30.8%) were the most abundant compounds that completely inhibited the germination of *Lepidium sativum*, *Raphanus sativus*, and *Eruca sativa* at concentrations of 4.0 and 8.0 $\mu\text{L ml}^{-1}$. The antimicrobial activity of the chloroform fraction of *Nepeta juncea* against *Salmonella typhi* was also reported by Hussain et al. [249].

3.3. *Ocimum*

The genus *Ocimum*, commonly known as basil, comprises around 60 species. They are widely distributed throughout tropical and subtropical Asia [137,141,250]. Due to its numerous pharmacological properties (Table 1), the plant is designated as “Holy Basil” in India. It is grown in the front of houses and temples by the Hindus, besides being cultivated for EO production. The EOs of *Ocimum* spp. have either phenolic constituents, eugenol, thymol, or sesquiterpene alcohols as single major oil constituents, or terpene compounds as minor constituents [55,56].

Culpeper [251] reported that *Ocimum* and *Ruta graveolens* never grow together, nor near one another; this was probably the first report about the allelopathic activity of any plant species of the Lamiaceae family. Since that, several reports have been found in the literature about the allelopathic activity of *Ocimum* species (Tables 2 and 3). Samunder and Megh [252] reported the autotoxic activity of *Ocimum leachte* (collected from soil). Likewise, soil incorporation of *Ocimum* root/shoot biomass in a 1:12 ratio (*Ocimum*: soil) had no inhibitory effect on the emergence of *Desmodium tortuosum*, *Sorghum halepense*, *Morrenia odorata*, *Amaranthus retroflexus*, *Senna obtusifolia*, *Bidens pilosa*, and *Cyperus esculentus*. However, *Ocimum* suppressed the growth of all those weed species, except *Cyperus esculentus*. The aqueous extract of *Ocimum basilicum* L. aerial parts showed a dose-dependent inhibition on the germination of *Sorghum bicolor* L. Moench, *Pennisetum glaucum* L. R. Br., *Zea mays* L., and *Triticum vulgare* L. [138]. A similar type of inhibition was also observed on the plant height, root length, seedling fresh, and dry weight of those crop seedlings when powder of its aerial parts was used.

Mota et al. [253] evaluated the insecticidal properties of EO of *Ocimum micranthum* Willd against *Aleurodicus cocois* (whitefly). They observed that the EO at 1% concentration was highly toxic to *A. cocois*, with faster mortality (6.82 h). They also identified eugenol, elemicin, and beta-caryophyllene as the major allelochemicals that were responsible for the insecticidal properties of *O. micranthum* essential oil.

3.4. *Lavandula* (Lavender)

The genus *Lavandula* comprises 40 species and around 80 wild infra-specific taxa and hybrids [254,255]. The *Lavandula* spp. is one of the important aromatic plants cultivated near the Mediterranean basin. *Lavandula angustifolia* Mill., *Lavandula stoechas* L., *Lavandula latifolia* Medik., and *Lavandula* × *intermedia* are the four major species of lavender. The EOs of *Lavandula* species are very well known for their myriad of pharmacological, toxicological, and pharmaceutical properties [146,147,217,218,256,257] (Table 1).

Lavender extracts and their EOs have allelopathic properties, as reported by many researchers worldwide (Tables 2–4). The aqueous extracts of *L. officinalis* shoot were allelopathic to weed species, including *Amaranthus retroflexus* and *Chenopodium murale* germination and growth [258]. Likewise, aqueous extracts of *L. stoechas* were phytotoxic to the germination and growth of both crop (*Triticum aestivum*) and weed (*Phalaris minor*) species [259]. The EOs of *L. stoechas* and *L. angustifolia* were also reported as phytotoxic to the seedling growth of *A. retroflexus* and *Portulaca oleracea*, two common weeds of *Lycopersicon esculentum* and *Gossypium* spp. [260]. Uremis et al. [261] reported that the volatile compounds of *L. angustifolia* negatively affect the germination of the most common weed species: *Xanthium strumarium* L., *Avena sterilis* L., and *Phalaris brachystachys* L.

Table 4. Allelopathic activity of Lamiaceae plant species under pot/greenhouse/field conditions.

Plant Species	Plant Organ	Mode of Application	Type of Experiment	Target Species	Effect	Reference
<i>Salvia officinalis</i> L.	Dried leaves biomass	Residue@7.5 t ha ⁻¹	Green house	<i>L. esculentum</i>	Inhibited the shoot length and dry biomass	[262]
		Residue@15 t ha ⁻¹		<i>Panicum maximum</i> Jacq.		
<i>Ocimum basilicum</i> L.	Aerial parts	Aqueous extract	Wire house	<i>Amaranthus</i> and <i>P. oleraceae</i>	Reduction in the fresh weight g/pot, and root and stem length	[140]
		Acetone extract (@40.48 kg ha ⁻¹ which equal 1% extract)	Field	All weeds found in the experimental field	Reduced the fresh weight of different weed species 21 days from spraying.	
	Fresh leaves	Aqueous extract	Pot	<i>P. minor</i> , <i>Anagalis arvensis</i>	Increasing concentration of up to 25% maximize the inhibitions of both weeds biomass (80%) in two consecutive seasons	[263]
<i>Lavandula</i> × <i>intermedia</i> cv. Grosso	Coumarin and plant extract	Leaf and stem extract	Cylindrical vials (50% soil: 50% peat moss)	<i>L. rigidum</i>	Shoot length and weight were significantly reduced by post-emergence application	[146]
<i>Mentha</i> × <i>piperita</i> L.	Leaves	Aqueous extracts	Green house	<i>H. annuus</i>	Reduced germination and chlorophyll a. Increased electrolyte leakage from seedlings, chlorophyll b, photochemical efficiency of photosystem II	[264]
<i>Mentha</i> × <i>piperita</i> L.	Mixture of two <i>Mentha</i> varieties	Volatiles	Glasshouse	<i>B. oleracea</i> convar. <i>capitata</i>	Stimulated leaf development and dry weight	[265]
<i>Mentha spicata</i> L. and <i>Mentha</i> × <i>piperita</i> L.	Introduction in crop rotation	-	Field experiment	<i>Z. mays</i>	Inhibited the plant height, biomass, photosynthetic rate, stomatal conductance, and relative chlorophyll content	[266]

Table 4. Cont.

Plant Species	Plant Organ	Mode of Application	Type of Experiment	Target Species	Effect	Reference
<i>Mentha</i> sp.	Dry leaves	-	Pot experiment	<i>B. napus</i> var. <i>oleifera</i>	Stimulated seedling emergence	[267]
<i>Mentha spicata</i> L.	Dry above ground biomass	-	Pot experiment	<i>L. esculentum</i>	Taller plants with thicker stems, higher chlorophyll content index, and photosynthetic rate and yield.	[268]
<i>Thymus fontanesii</i> Boiss. et Reut.	Dried aerial parts	EOs	Greenhouse	<i>S. arvensis</i> , <i>Avena fatua</i> L., <i>S. oleraceus</i> , <i>X. strumarium</i> and <i>C. rotundus</i>	Wilting, leaf chlorosis, necrotic spots and desiccation, reduced chlorophyll content	[28]
<i>Thymus</i> sp.	Thymol	-	Pot experiment	<i>L. sativa</i>	Inhibited the shoot fresh and dry weights and photosynthetic rate. Promoted photosystem II, total protein concentration, proline content, antioxidant enzymes (poly-phenol oxidase, ascorbate peroxidase and catalase)	[269]
<i>Hyptis spicigera</i>			<i>Z. mays</i> was following fallow with <i>H. spicigera</i>	<i>Striga hermonthica</i>	Reduced <i>S. hermonthica</i> incidence and increased <i>Z. mays</i> yield	[270]
			Intercropping maize and <i>H. spicigera</i>		Negatively affected maize growth, resulting in reduced maize yields	
<i>Tectona grandis</i>	Fresh leaves	Leachates	Pot culture	<i>V. unguiculata</i> , <i>M. charantia</i> and <i>S. melongena</i> L.	Inhibited the seed germination and seedling growth	[197]
<i>Calamintha nepeta</i> L. (Savi)	Above ground parts	Residue	Pot culture	<i>L. sativa</i> , <i>C. album</i> , <i>S. alba</i>	Inhibited the shoot and root growth	[202]

Haig et al. [146] examined the allelopathic activity of *Lavandula* spp. against *Lolium rigidum*. They reported that the extract at the concentration of 10% completely inhibited the root growth of the test species and that coumarin was the main allelochemical responsible for its phytotoxicity. The EOs (linalool and linalyl acetate) of *Lavandula × hybrida* Rev. were evaluated against the germination and seedling growth of two crops (*Triticum aestivum* L. and *Hordeum vulgare* L.) and two weeds (*Lolium rigidum* L. and *Phalaris brachystachys* L.), where the EOs showed no effect on crop species but inhibited the germination and seedling growth of both weeds [218]. Similarly, *Lavandula angustifolia* Mill. EOs, terpinen-4-ol, lavandulol and linalyl acetate, and lavandulyl acetate completely inhibited the germination and root length of *Setaria verticillata* (L.) P. Beauv. at concentrations of 80, 160, and 320 nL mL⁻¹, respectively [217]. Recently, two new tricyclic sesquiterpenoids, stoechanones A and B have been isolated from the organic extract of *Lavandula stoechas*, which exhibited strong phytotoxicity against the germination and seedling growth of *Amaranthus retroflexus* [219].

3.5. *Mentha*

The genus *Mentha* (commonly known as mint) has 61 species and hundreds of subspecies, varieties, and cultivars, which are widely distributed throughout the world, except South America and Antarctica [220,271,272]. The species of this genus are also well known for their relatively high content of EOs and a significant number of medicinal and pharmaceutical properties [271–274] (Table 1). The allelopathic properties of *Mentha* spp. from their different parts (leaves, stem, flowers, seeds, and roots) and fractions (essential oils, volatiles, below ground soils, dry biomass) under several experimental settings (laboratory, greenhouse, pot or field conditions) have been well documented, as shown in Tables 2–4.

The major allelochemicals isolated from the EOs of *Mentha* spp. known to date are piperitone oxide and piperitenone oxide from *M. longifolia* (L.) Huds.; carvone, piperitenone oxide from *M. spicata* L.; (-)-menthol, menthone from *M. × piperita* L.; menthol, mentone, menthofuran from *M. × piperita* L. cv. Mitcham; pulegone, menthone from *M. pulegium* L. and *M. × piperita* and menthone/isomenthone from *M. spicata*, *M. crispa*, and *M. longifolia* (Table 2). In addition, *trans*-ferulic acid, hesperidin, ellagic acid, and sinapic acid have been isolated from the aqueous extract of *M. × piperita* L. cv. Mitcham [148,225]. All these compounds either inhibited (at high concentration) or stimulated (at low concentration) the germination, growth, and other morpho-physiological processes of different test species (Table 2). Maffei et al. [275] reported that an increase of *Mentha piperita* L. EOs concentration from 5 to 50 ppm decreased the membrane potential hyperpolarization of 10^{-3} mV, while concentrations from 100 to 900 ppm decreased the depolarization of membrane potential (from 5 to 110 mV). In another study, Skrzypek et al. [264] reported that increasing concentrations of aqueous extracts of *M. × piperita* L. decreased the chlorophyll *a*, while increasing the chlorophyll *b* content of *Helianthus annuus* L. Sarheed et al. [224] found that menthone disrupted the microtubules and induced mortality, linked with rapid permeabilization of the plasma membrane of both tobacco BY-2 cells and *Arabidopsis thaliana* seedlings.

In a pot experiment, direct incorporation of *M. spicata* L. plant residue into the soil could boost tomato tolerance against soil-borne fungi and soil fertility, and accordingly increased the yield and quality of the tomato [264]. Similarly, mixed cultivation of two *M. × piperita* varieties in glasshouse stimulated the leaf development of *Brassica oleracea* [265], and application of dry leaves of *M. spp.* in pots also stimulated the seedling emergence of *Brassica napus* [267]. By contrast, the introduction of *M. spicata* L. and *M. piperita* L. in crop rotation inhibited the plant height, biomass, photosynthetic rate, stomatal conductance, and relative chlorophyll content of maize [266].

3.6. Thyme

The genus *Thymus* comprises around 400 species, with several subspecies, varieties, sub-varieties, and forms. *Thymus* species are extensively used as a culinary herb in both fresh and dried forms [155,276]. The plants of this genus are widely used in different industries, due to their numerous pharmacological, pharmaceutical, cosmetic, perfume, and toxicological properties [276–281] (Table 1). *Thymus* species are also used for flavoring and preservation of different foods [279]. A significant number of articles are available in the literature explaining the allelopathic properties of *Thymus*.

Ali et al. [155] reported the inhibitory activity of *Thymus numidicus* Poir. root extract on the seedling growth of *Medicago sativa* and *Triticum aestivum*. The essential oils of *T. daenensis* strongly inhibited the germination percentage (IC_{50} 2.9 ppm) of *Lactuca sativa* and were lethal to the embryo (LC_{50} 7.2 ppm), while *T. transcaspicus* delayed the germination time of the same [3]. On the other hand, Ali et al. [227] reported the phytotoxic potential of *T. algeriensis* Boiss. Et Reut. leaf oils on the seedling growth of *M. sativa* and *Triticum aestivum*. They also reported that α -pinene (19.5%), 1,8-cineole (11.6%), and camphor (10.4%) were the major constituents of *T. algeriensis*. These oils were found to possess strong insecticidal activity (LC_{50} = 44.3–112.8 $\mu\text{L L}^{-1}$ air) against the third instar larvae of cotton leafworm (*Spodoptera littoralis* Boisd.; Lepidoptera: Noctuidae). The EOs (mainly thymol, 60.48%) of *T. kotschyanus* showed phytotoxic activity (>500 ppm concentration) against *Amaranthus retroflexus* L. and *Panicum miliaceum* L., fungicidal activity (>500 ppm concentration) against *Aspergillus niger*, *Botrytis cinerea*, and *Penicillium expansum*, and insecticidal activity against *Oryzaephilus surinamensis* (LC_{50} = 4.78 $\mu\text{L L}^{-1}$ air) [281]. The EOs of *T. vulgaris* (mainly thymol and carvacrol) showed insecticidal activity against *Alphitobius diaperinus* Panzer (Coleoptera, Tenebrionidae) at the early stage of growth [282].

3.7. Hyptis

The genus *Hyptis* is composed of 400 species that mainly occur in tropical America, but are also found in other regions of the world [283]. The species of this genus is tradi-

tionally used to treat various ailments [76,284] (Table 1). A few are considered as invasive weeds in some parts of the world, and possess allelopathic properties. For example, *Hyptis suaveolens* (L.) Poit is an important invader of tropical and sub-tropical regions, and that restricted the growth and establishment of other plant species near their clumps [77,285–287]. A plausible reason could be their allelopathic properties [78,160,164,288,289]. This statement is supported by the isolation and identification of a putative allelochemical 14 α -hydroxy-13 β -abiet-8-en-18-oic acid (suaveolic acid) from this plant species by Islam et al. [32].

A number species from this genus also have insecticidal and repellent properties. For example, Tripathi and Upadhyay [290] reported the insecticidal (LD₅₀ value of 57.0 mg mg⁻¹ weight of insect and 4.7 mg L⁻¹ air) and repellent (% repellence ranged from 20.0 to 94.7% at 18.3 mg cm⁻² for 5 h) properties of *H. suaveolens* leaf EOs on stored grain coleopteran pests, e.g., *Callosobruchus maculatus*, *Rhyzopertha dominica*, *Sitophilus oryzae*, and *Tribolium castaneum*. The major EOs responsible for this activity identified were sabinene (41.0%), terpinen-4-ol (12.31%), β -pinene (10.0%), and β -caryophyllene (8.0%). Conti et al. [291], on the other hand, reported the larvicidal (more than 90% mortality at concentration > 400 ppm) and repellent properties of *H. suaveolens* EOs against *Aedes albopictus* Skuse. Terpinolene was the major compound responsible for this activity. The insecticidal and repellent properties of *H. suaveolens* EOs against *Tenebroides mauritanicus* (L.) (peanut pest) were also reported by Adjou et al. [292].

The insecticidal properties of *H. Spicigera* Lam. were reported by Fragoso-Serrano et al. [293] and Noudjou et al. [294]. The Labdane type diterpenes 15,19-diacetoxy-2*R*, 7*R*-dihydroxyabda-8(17), (13*Z*)-diene isolated from *H. spicigera* significantly inhibited the larval growth of the European corn borer [293]. Araújo et al. [283] reported the insecticidal properties of *H. martiusii* Benth EOs against *Aedes aegypti* larvae (vector of dengue fever) and *Bemisia argentifolii* (vector of white fly fruit plague). Whereas, the antifungal activity of *H. ovalifolia* leaves EOs was reported by Souza et al. [284].

3.8. *Leucas*

The genus *Leucas* comprises about 80 species, of which 43 species are available in India [295], whereas the highest species diversity is found in East Africa [79,296]. Similar to other genus of Lamiaceae, the species of *Leucas* have also been widely used by traditional healers to cure many human ailments [23,25], because of its many pharmaceuticals and toxicological properties [297] (Table 1). These genus features indicated its immense potential for the discovery of novel allelopathic compounds. Although the phytochemical study of *Leucas* started many years back, very few allelopathic studies with this plant have been done so far. Islam and Kato-Noguchi [169] reported the phytotoxic properties of *Leucas aspera* (Willd.) Link against several weeds. The methanol extract of *L. aspera* (at 100 mg DW equivalent extract mL⁻¹) showed stronger phytotoxic activity against *Echinochloa crus-galli* [298]. Islam et al. [30] isolated and characterized an equilibrium (or inseparable) 3:2 mixture of two labdane type diterpenes, (rel 5*S*,6*R*,8*R*,9*R*,10*S*,13*S*,15*S*,16*R*)-6-acetoxy-9,13;15,16-diepoxy-15-hydroxy-16-methoxyabdana and (rel 5*S*,6*R*,8*R*,9*R*,10*S*,13*S*,15*R*,16*R*)-6-acetoxy-9,13;15,16-diepoxy-15-hydroxy-16-methoxyabdana from the aqueous methanol extract of *L. aspera*. This mixture inhibited the germination and seedling growth of allelopathic sensitive *Lepidum sativum* (IC₅₀, 31 μ M) and the most noxious weed, *Echinochloa crus-galli* (IC₅₀, 80 μ M), at concentrations higher than 30 and 3 μ M, respectively.

3.9. *Leonurus*

Similar to the other genus of Lamiaceae, *Leonurus* species also has myriad medicinal properties (Table 1) and are used by herbalists to treat gynecological and obstetrical disorders in China, and anxiety and heart diseases in European countries [299]. To date, 24 species of *Leonurus* have been identified. *Leonurus japonicus* (also known as *L. heterophyllus*) and *L. cardiaca* are the distinctive species of Eastern Asia and Europe, respectively [299]. Some other dominant species of *Leonurus* include *L. japonicus*, *L. cardiaca*, *L. persicus*, *L. sibiricus*, *L. macranthus*, *L. turkestanicus*, and *L. glaucescens*.

Very little is known about the allelopathic and phytotoxic properties of the species from this genus. The few articles related to their allelopathy are mostly with *L. sibiricus*. In addition, most of the reports of *L. sibiricus* allelopathy have mainly been based on simple laboratory bioassay experiments (Tables 2 and 3). Mandal [235] reported that caffeic acid, isolated from the root exudates, is responsible for the growth inhibitory activity of *L. sibiricus*. Almeida et al. [236] isolated three major allelopathic compounds, 3'-OH-genkwanin, rutin, and isoquercitrin, from the methanol extract of *L. sibiricus*. Other than these, Wu et al. [300] isolated (–)-loliolide from *L. japonicus*. The phytotoxic properties of loliolide (isolated from the species of other plant families) for different test species has been reported by a few researchers from Japan and China [301–304]. Moreover, Labdane diterpenoids are the typical compounds of *Leonurus* [299]. The mixture of the two members of this group is responsible for the allelopathic activity *Leucas aspera* [30]. A Labdane-type diterpene isolated from *Hyptis spicigera* inhibited the larval growth of the European corn borer [293], as reported earlier.

3.10. *Origanum*

Origanum, commonly known as oregano, is an important culinary genus of Lamiaceae. It comprises around 900 species and is distributed throughout the world [86,87]. Considering pharmacological, pharmaceutical, and toxicological properties, the species from this genus are not different from other Lamiaceae genus (Table 1). A number of research works have been conducted to explore the allelopathic potential of *Origanum* plants or their essential oils (Tables 2 and 3).

Among the allelopathic substances identified to date from *Origanum* EOs, carvacrol, thymol, γ -terpinene, p-cymene, β -cymene, methyleugenol, myristicin, caryophyllene oxide, β -caryophyllene, and α -cadinol are the major compounds that showed inhibitory activity on the germination, growth, and physiological parameters of different test species at different inhibition values (Table 3). *Origanum syriacum*, *O. vulgare* ssp. *vulgare* L., *O. vulgare* ssp. *hirtum*, *O. acutidens*, *O. onites*, *O. compactum* Benth., and *O. majorana* L. are the dominant species of *Origanum* that showed allelopathic properties [3,37,174–179].

3.11. *Rosmarinus* (Rosemary)

Rosmarinus, another popular genus of Lamiaceae family, comprises three different species, e.g., *R. officinalis*, *R. eryocalix*, and *R. tomentosus*, mainly found in the western Mediterranean region. Similar to other genus of this family, *Rosmarinus* also has a number of medicinal properties (Table 1). However, the genus is very popular as a culinary herb and is used as a food flavoring or food preservative [89]. Few allelopathic reports of *Rosmarinus officinalis* were found in literature (Table 2). The major allelochemicals of *R. officinalis* EOs are α -pinene, 1,8-cineole, and piperitone, which significantly inhibited the germination and seedling growth of weed species, e.g., *Eleusine indica* (L.) Gaertn., *Cynodon dactylon* (L.) Pers., *digitaria sanguinalis* (L.) Scop., *Amaranthus retroflexus* L., and *Lolium perenne* [39,89]. Najem et al. [180] also reported the anti-cyanobacterial activity of *R. officinalis* essential oil on *Microcystis aeruginosa* and *Chroococcus minor*, where *M. aeruginosa* was more sensitive than *C. minor*. However, no reports related to the allelopathic properties of *R. officinalis* under field conditions were found in literature.

3.12. *Hyssopus* (Hyssop)

Hyssopus is a small aromatic medicinal genus of the Lamiaceae family, comprising only 70 species, of which *Hyssopus officinalis* L. is the most dominant [305]. Very little work has been conducted to explore the allelopathic activities of this genus so far. Dragoeva et al. [173] reported its allelopathic properties from a preliminary laboratory bioassay of *Hyssopus officinalis* on *Cucumis sativus* L., *Triticum aestivum* L., and *Allium cepa* L. However, Ortiz de Elguea-Culebras et al. [306] reported that 1,8-cineole (53%) and β -pinene (16%) are the major bio-active compounds of the EOs of *H. officinalis* that are insecticidal to *Spodoptera littoralis* (cotton leafworm). They also reported that *H. officinalis* EOs have no inhibitory

effect on the germination of *Lactuca sativa* L. var. *Carrascoy* and *Lolium perenne* L., but have a slight inhibitory effect on the root and leaf growth of *L. perenne*.

3.13. *Orthosiphon*

Orthosiphon is another small Lamiaceae genus that comprises around 40 species, distributed throughout the tropical and sub-tropical Asia, Southern Africa, Madagascar, and some parts of Australia [100]. Some species of this genus have medicinal properties (Table 1); among them, *Orthosiphon aristatus*, *Orthosiphon thymiflorus*, *Orthosiphon pallidus*, and *Orthosiphon stamineus* are very well known [100]. To date, the allelopathic properties of only two species *Orthosiphon stamineus* and *Orthosiphon aristatus* have been reported in the literature. Suwitchayanon et al. [307] observed 75% root and 45% shoot growth inhibition of *Lactuca sativa* by the dried powder of *Orthosiphon aristatus* with a modified sandwich method, under laboratory conditions. While, the aqueous methanol extract of *Orthosiphon stamineus* showed inhibitory activity on the seedling growth of *Lepidium sativum* and *L. sativa*, and a novel allelopathic substance 13-epi-orthosiphol N was identified by Kato-Noguchi et al. [200]. This compound inhibited the root and shoot growth of *L. sativum* and *L. sativa* at concentrations higher than $10 \mu\text{mol L}^{-1}$, and the concentrations required for 50% growth inhibition ranged 41–102 $\mu\text{mol L}^{-1}$ [200].

3.14. *Tectona*

Tectona is a genus of tropical hardwood trees and comprises three species: *T. grandis*, *T. hamiltoniana*, and *T. philippinensis* [104]. *T. hamiltoniana* and *T. philippinensis* are now considered endangered species and confined to Burma and the Philippines, respectively. The most common species, *T. grandis* is native to South and Southeast Asia and is widely distributed to tropical Asia, Africa, and Central and South America, due to its quality timber [308–312]. Besides its high-quality timber properties, the genus *Tectona* is well known for its ethnobotanical and toxicological properties [40,104].

Recently, Kato-Noguchi [104] reviewed the allelopathic properties of *Tectona grandis* L.f. The leachate, leaves, EOs, and underground soil of *T. grandis* had allelopathic properties and inhibited the morpho-physiological growth of several crop species (Tables 2–4). Kole et al. [313] applied the powder of fallen *T. grandis* leaves ($100 \text{ g } 7.2 \text{ m}^{-2}$) in a wheat field and observed a 45% reduction in weed population at 21 days after application, but interestingly the powder did not affect the wheat growth. Macías et al. [245] reported two diterpenes; 2-oxokovalenic acid and 19-hydroxyferruginol from the water extract of the dried leaves of *Tectona grandis*, which inhibited the germination and growth of *Lactuca sativa*. The highest inhibitory effects on the germination were caused by 2-oxokovalenic acid, which showed activity values similar to the herbicide Logran[®] at the highest concentrations (89% inhibition at 10^{-3} M concentration). However, both compounds stimulated the root growth of *Lycopersicon esculentum*, with values higher than 20% for all concentrations.

Lacret et al. [314] isolated naphthotectone from the dried leaves of *T. grandis* that inhibited the germination and seedling growth of *Triticum aestivum* L., *Allium cepa* L., *Lycopersicon esculentum* L., and *Lactuca sativa* L. Macías et al. [315] on the other hand isolated 3 β -hydroxy-7,8-dihydro- β -ionol and 3 β -hydroxy-7,8-dihydro- β -ionone from the dried leaves. Both compounds inhibited the seedling growth of *Triticum aestivum*, *Allium cepa*, and *Lycopersicon esculentum*. All these compounds showed an activity similar to the commercial herbicide Logran[®]. It is important to note that all the above mentioned bioactive compounds were isolated from the water extract of *T. grandis* dried leaves, and their activity was examined only against crop species. Hence, it may be necessary to evaluate the phytotoxic potential of those compounds against weed species.

3.15. *Satureja* (Savory)

Satureja, a well-known genus from the Mediterranean area, Asia and some parts of USA, includes more than 200 aromatic species [105]. The species of this genus has also traditionally been used for gastrointestinal cramps, diarrhea, nausea, muscle pains, and

some other infectious diseases, because of their various medicinal properties [316] (Table 1). Due to their characteristic smell, a few species of this genus are also used for culinary purposes and herbal tea [317]. A negligible number of allelopathic reports of *Satureja* species have been published so far. The aqueous extract of *Satureja montana* L. [185,187], *Satureja thymbra* L. [186], *Satureja khuzestanica* Jamzad, *S. bachtiarica* Bunge, and *S. rechingeri* Jamzad [189], *Satureja hortensison* L. [190] aerial parts significantly inhibited the germination and growth of the tested species (Table 2). Beside these, two allelopathic compounds; carvacrol and γ -terpinene have been isolated from the aerial parts of *Satureja hortensis* L., which inhibited the germination and growth of *Lolium rigidum* L. and *Phalaris brachystachys* L. [218], and from its EOs, which inhibited the germination, root and shoot growth, and chlorophyll content of *Amaranthus retroflexus* and *Chenopodium album* [244]. In addition, Taban et al. [107] isolated carvacrol and thymol from the EOs of *Satureja* spp., *S. khuzestanica*, *S. bachtiarica*, *S. rechingeri*, and *S. spicigera*, which inhibited the germination and growth of *Secale cereale* and *Lycopersicon esculentum* at different inhibition values. Among them, EOs isolated from *S. khuzestanica* were highly phytotoxic and were suggested for bio-herbicide development [107].

Askun et al. [318] reported strong fungicidal effects of *S. icarica*, *S. coerulea*, and *S. cilicica* methanolic extracts at high concentrations of 6.3 to 12.5 mg mL⁻¹ and fungistatic effects at lower concentrations. They identified carvacrol, hesperidin, and apigenin from *S. icarica*; rosmarinic acid, carvacrol, and caffeic acid from *S. coerulea*; and rosmarinic acid, hesperidin, and quercetin from *S. cilicica* methanolic extracts as the major compounds.

3.16. *Conradina*

Conradina, a small aromatic genus of the Lamiaceae family, is mainly found in the xeric environments with well drained sandy soil of the United States [109]. The family consists of six endemic species: *Conradina canescens* A. Gray, *C. cygniflora* C.E. Edwards, Judd, Ionta & Herring, *C. etonia* Kral & McCartney, *C. glabra* Shinners, *C. grandiflora* Small, and *C. verticillata* Jennison [319]. The species of this genus has colonizing ability in xeric disturbed soils [109]. Among the six species of *Conradina*, only the allelopathic potential of *C. canescens* has been reported in the literature to date.

Water leachate of *C. canescens* fresh leaves have germination and growth inhibitory potential, and eight monoterpenes: 1,8-cineole, camphor, borneol, myrtenal, myrtenol, α -terpineol, carveol, and carvone were identified from this leachate [320]. The saturated aqueous extract of these monoterpenes showed strong phytotoxicity against *Leptochloa dubia*, *Schizachyrium scoparium*, and *Lactuca sativa*, except 1,8-cineole, which did not affect *L. dubia* [321,322]. Dosoky [323] observed the inhibitory activity of *C. canescens* essential oil and isolated ursolic acid on the germination of *Lactuca sativa* and *Lolium perenne*. The presence of ursolic acid has a major role in the allelopathic potential of this species. This compound is thought to act as a natural detergent, by leading water-insoluble monoterpenes to form micelles, rendering them water-soluble; thus, boosting their ability to leach into rainwater for delivery into the soil [324]. Moreover, this compound helps co-solubilize the allelopathic monoterpenes in water and make them more effective [325].

3.17. *Coleus*

Coleus, another medicinal and aromatic genus of Lamiaceae [326,327], comprises 294 species found in the tropics and subtropics of Europe, Asia, Africa and Australia [115] (Table 1). The allelopathic properties of a few *Coleus* species have been reported (Table 2). Kathiresan [204] observed that a water suspension of *Coleus amboinicus* L. leaf dried powder at 40 g L⁻¹ reduced the fresh and dry weight of *Echhornia crassipes* by 81 and 76%, respectively, within a week. The lowest dose required to kill *E. crassipes* was 10 g L⁻¹. The extract was even injurious at 0.1 g L⁻¹ when applied to cut leaves of *E. crassipes*. In another study, Gnanavel and Kathiresan [203] reported the allelopathic properties of *Coleus* spp. varied among their different parts. For example, dried leaf powder at 25 g L⁻¹ of water was found to be most effective in reducing the fresh weight and chlorophyll content of

E. crassipes and showed a 100% reduction on 9 and 6 days after treatment, respectively [203]. The second highest inhibitory activity was found when 3/4th of dried leaf powder at 18.75 g L^{-1} + 1/4th of dried whole plant powder at 6.25 g L^{-1} was applied. Interestingly, dried stem powder at 25 g L^{-1} showed a minimum reduction on those two parameters [203]. The aqueous leaf extracts of *Coleus forskohli* significantly inhibited the seed germination, root-shoot length and dry weight, and sugar and protein content of *Triticum aestivum*, while the opposite activity was found for total amino acid contents [205].

3.18. *Calamintha*

Calamintha, a small aromatic genus of Lamiaceae, is mainly distributed in the Mediterranean region [29,117]. The species of this genus also are traditionally used as folk medicines. Some *Calamintha* species are used for culinary purposes and herbal tea [117]. The allelopathic properties of *Calamintha* spp. with weeds and crop species under laboratory and field conditions have been reported in the literature (Tables 2–4).

Tanrisever et al. [328] isolated and identified menthofuran, calaminthone, terpenoids (+)-evodone, caryophyllene oxide, and ursolic acid from the aerial parts (through NMR and MS), and menthofuran and 2,3-dihydroevodone from the volatiles (through GC-MS) of *C. ashei*. The seed germination of *Schizachyrium scoparium* was strongly inhibited by the evodone and calaminthone volatiles. While, 100% inhibition on the seed germination of *S. scoparium* was observed when the seeds were subjected to a fraction of the aqueous solution containing calaminthone, evodone, and caryophyllene oxide. Interestingly, these fractions had no significant effects on *Lactuca sativa* seed germination. On the other hand, a stimulatory activity on *S. scoparium* was observed when a saturated aqueous solution of pure evodone was applied. In contrast, the opposite activity was found when evodone was applied together with the saturated aqueous solution of ursolic acid. Weidenhamer et al. [329] isolated and identified (+)-evodone and desacetylcalaminthone as the major constituents of *C. ashei* leaf soaks and washes through reversed-phase HPLC. They reported that an equimolar mixture of desacetylcalaminthone and (+)-evodone inhibited the germination of *Rudbeckia hirta* L. by 17% at a combined concentration of 0.025 mM, while the germination of *S. scoparium* (Mich x.) Nash cv. Cimarron and *Leptochloa dubia* (H.B.K.) Nees. was not affected below the concentrations of 0.125 and 0.25 mM, respectively. Besides the allelopathic properties of *Calamintha* spp., their species have insecticidal and antimicrobial properties. Božović and Ragno [117] reviewed the biological properties of *C. nepeta* (L.) Savi and its essential oils. The bioactive EOs constituent 'pulegone' of *C. nepeta* is considered as one of the three most toxic insecticides naturally occurring in many Lamiaceae species [273,330], because of the repellent, antifeeding, antidevelopment, and anti-reproduction behavior of pulegone for different harmful insects [331–333].

4. Knowledge Gaps and Future Prospects

In general, plants with medicinal properties are considered important sources of bioactive compounds [5]. Scientists are, therefore, showing interest in this category of plants for searching for novel bioactive compounds. The easier screening process for allelopathic plants and the possibility of having more bioactive compounds from medicinal plants than other plants are the two main reasons for this interest [142]. It is assumed that, due to the presence of many pharmacological, pharmaceutical, and toxicological properties, Lamiaceae occupies 43% of the total studied species among the plant families examined for their bio-herbicide potentialities [334]. Although this is a huge number compared to other plant families, there is a lot of empty space for researchers to work with the species of this family, to explore their allelopathic potential. However, the structural complexity, cost and time involvement in structure determination, labile characteristics of some compounds, and drawbacks in obtaining sufficient quantities for structure elucidation are amongst the major constraints for the isolation and characterization of allelopathic substances.

Beside these issues, most of the works were conducted in different laboratories with different setups, and thus it is rather difficult to compare the effectiveness of crude extracts,

dried plant materials, or purified allelochemicals from different species as potential natural herbicides. Some purified allelochemicals were examined for their inhibitory activities on seed germination and/or the plant growth of crops and weeds, and they were far less active than commercial pesticides; although in most cases, commercial herbicides were not included as positive controls in the assays. The most effective allelochemicals appear to be volatile monoterpenoids, but some of these are also toxic to animals [13], and must, therefore, be used with caution. In fact, the challenges of finding greener herbicides have been discussed across fields [13,335,336]. If these limitations can be overcome, there is huge potential for using allelopathy/allelopathic substances of Lamiaceae plants in agriculture, as detailed below:

(i) **Organ-specific:** The allelopathic activities of some plants of this family are organ-specific. For example, the allelopathic activity of *N. meyeri* depended on whether the extract was derived from the leaves or roots, and maximum inhibitory activity was found with leaf extracts [135]. Similarly, dried leaf powder of *Coleus* spp. at 25 g L⁻¹ of water significantly reduced the fresh weight and chlorophyll content of *E. crassipes*, while dried stem powder at the same concentration showed a minimal reduction on these two parameters [203].

(ii) **Test plant-specific:** It is assumed that the allelopathic plants or their allelochemicals that will be used for crop protection should be non-toxic or stimulatory to the crops. Nevertheless, in reality, this is not always true. However, many essential oils (EOs) of Lamiaceae species showed test plant-dependent inhibitory activity, where crops were less affected than weeds. For instance, linalool and linalyl acetate of *Lavandula × hybrida* showed phytotoxic activity against weeds (*Lolium rigidum* and *Phalaris brachystachys*) and no activity against crops (*Triticum aestivum* and *Hordeum vulgare*) [218]. The EOs of *Satureja hortensis* inhibited the germination of *A. retroflexus* at a lower concentration, while tomatoes were unaffected at the same concentrations. At the highest tested concentration, tomato germinations were affected, but less than *A. retroflexus* [34]. Similarly, when applying EOs of *Origanum onites* and *Rosmarinus officinalis* to the germination and seedling growth of *Avena sterilis*, *Sinapis arvensis*, and wheat cultivars, the wheat cultivars were less affected [37]. Kole et al. [313] reported a 45% reduction in weed population at 21 days after application but no effect on the *Triticum aestivum* growth by *Tectona grandis* fallen leaf powder in field conditions. In contrast, Lacret et al. [314] and Macías et al. [315] reported the germination and seedling growth inhibition of *Triticum aestivum* by EOs isolated from the dried leaves of *T. grandis* under laboratory conditions. The root and leaf extracts of *Nepeta meyeri* showed an allelopathic effect on the germination and seedling growth of barley and sunflower, while having no inhibitory activity on *Triticum aestivum* [135].

(iii) **Phytotoxic under natural settings:** Although thousands of species from different families or their isolated allelochemicals have been reported as allelopathic in the literature, most of them were laboratory experiments, and a few were greenhouse or field trials. A negligible number of reports are found in the literature where plant species showed allelopathic activity under natural settings. The Lamiaceae species, *Salvia leucophylla* and *Nepeta meyeri* belong to this short list that showed allelopathic activity under natural settings [119,209]. *Leucas aspera* and *Hyptis suaveolens* also form colonies under natural settings that suppress the growth of surrounding neighboring species, where allelopathy might play a vital role [30,32].

(iv) **Presence of ursolic acid:** Ursolic acid is present in some Lamiaceae species, which has a great role in their allelopathic activities. This ursolic acid is considered a natural detergent that makes the water-insoluble monoterpenes water-soluble and, consequently, boosts their ability to leach into rainwater for delivery into the soil [324].

(v) **Terpenes as the major compounds:** Terpenoids are the major group of plant specialized metabolites with allelopathic properties [181,337]. These compounds use IPP as a substrate which derives from either the MEP pathway [338] or the MVA pathway [339]. There are several types of terpenes, e.g., monoterpenes, sesquiterpenes, diterpenes, triterpenes, and polyterpenes [340]. Among them, monoterpenes (major elements of EOs) are most often reported to have herbicidal activity [181,334]. It is evident from this re-

view that Lamiaceae species are rich sources of several allelopathic monoterpenes, e.g., camphor, α -pinene, β -pinene, 1,8-cineole, carveol, carvone, and camphene. Cinmethylin, a monoterpene-based commercial herbicide derived from 1,4-cineole, is already available on the market [341]. However, among the monoterpenes, the ketone-containing compounds, camphor and pulegone, are the most toxic, followed by alcohol compounds (cineol and citronellol), while ether, diene, and monoene compounds (α -pinene) are the least toxic [341,342]. In addition, pulegone is considered one of the three most toxic natural insecticides in the world [273,330].

(vi) **Presence of volatile compounds:** Although plant volatiles are considered an important tool for pest management in organic agriculture [343], unlike other mechanisms of allelopathy, very little research has been conducted to date to examine the effects of volatiles in plant–plant interactions [208]. It has been reported that plant volatiles mainly belong to the terpenoids, fatty acid derivatives, and phenolics groups [344]. As stated earlier, Lamiaceae species are rich sources of volatile EOs that are phytotoxic; for example, pulegone, α -pinene, limonene, 1,8-cineole, carvacrol, camphor, thymol, etc. [27,41–43,341,345]. Several plant-originated monoterpenoids are more toxic to nematodes than commercial nematicides. Compounds such as thymol and carvacrol have been found to be the most effective, with 100% mortality [346]. Furthermore, eugenol, geraniol, isoeugenol, and methyl isoeugenol also have nematicidal properties [347].

(vii) **Scalable by biotechnology:** Traditional breeding has been adopted for Lamiaceae species, especially the ones that are an important source of essential oils, such as mint [348,349] and catnip [350,351]. The recent findings in the botany and horticulture of catnip have been reviewed, and the interest in scaling up catnip to industrial scale was also discussed in Gomes et al. [352]. This evidence supports our view of further utilizing and exploring Lamiaceae in sustainable agriculture. With the recent advance in sequencing technologies, the genomes of many Lamiaceae species have been sequenced. This includes species in *Salvia* [353,354], *Nepeta* [355], *Lavendula* [356], *Ocimum* [357], and *Mentha* [358], whose allelopathy was described above. In addition, more transcriptomes are available on several platforms, such as the mint genome project (<http://mints.uga.edu>, accessed on 13 January 2022) and OneKP [359]. The availability of omics data allows scientists to gain fundamental knowledge of terpene biosynthesis and adopt biotechnology tools to increase the yield and productivity of the targeted compounds. Many synthetic biological and metabolic engineering approaches have successfully created production platforms for terpenoids. Zebec et al. [360], and more recently Zhang and Hong [361], have comprehensively reviewed the synthetic biology approach for monoterpene production in *Escherichia coli* and *Saccharomyces cerevisiae*, the industrial workhorses. The metabolic engineering attempts and significant milestones of terpenoid production in planta were also discussed by Mani et al. [362]. To date, the cell-free enzyme system from *E. coli* has shown the highest yield of monoterpene production, which is up to 14–15 g L⁻¹ [363]. The fed-batch fermentation system from *E. coli*, which is more feasible on an industrial scale, can produce limonene up to 3.6 g L⁻¹ [364]. Therefore, it is highly likely that the allelopathic compounds of interest in Lamiaceae can be synthesized on an industrial scale, by taking advantage of the recent discoveries in genetics, breeding, biochemistry, and synthetic biology. This advantage of these biotechnological tools may help overcome the challenges in field testing, by making the allelopathic compounds more accessible.

These special features of allelopathic plants from Lamiaceae families, or their isolated allelochemicals, may help researchers develop natural product-based crop or weed specific herbicides and insecticides. Although the utilization of allelopathy in agriculture could be achieved with the incorporation of allelopathic plant residues into soils or with mulching, the application of water extracts or essential oils from allelopathic plants, and allelochemicals produced artificially (organic synthesis, fermentation, tissue culture, etc.) [5], and extraction with organic solvents should be avoided for green allelopathy. Therefore, a huge amount of research with allelopathic Lamiaceae plant species remains to be conducted, both under controlled laboratory and field conditions, to harness their maximum potential

for agricultural purposes. A significant amount of research is also needed to explore the mechanisms of action, impacts on beneficial crops, insects, and other organisms, formulations for effective application, and to assess the cost–benefits of allelochemicals identified from Lamiaceae species.

5. Conclusions

Researchers have always had a keen interest in the Lamiaceae plant species because of their multitude of pharmacological and pharmaceutical properties and the presence of bioactive EOs. However, considering the number of plant species, a significant amount of research is yet to be conducted, to explore the allelopathic activity of the Lamiaceae family. As for other plant families, most of the research works carried out to date have mainly focused on the inhibitory properties of Lamiaceae plant extracts and their EOs on the germination and seedling growth of several target species, under controlled laboratory or greenhouse conditions. Therefore, the transfer of laboratory and greenhouse experiments into field settings is imperative, for understanding the environmental impacts on the herbicidal/pesticidal activity of the allelochemicals of Lamiaceae plants or their EOs on target species. In addition, the biostimulatory activities of allelochemicals/EOs at lower concentrations should also be given more priority. With this review, we provide the current stage of the research in allelopathy and point out the potential of allelopathy in Lamiaceae species as a source of greener alternative herbicides, along with the gaps in knowledge that need filling for introducing natural allelopathic substances to agriculture.

Author Contributions: Conceptualization and methodology: A.K.M.M.I.; data collection: A.K.M.M.I.; data handling and analysis: A.K.M.M.I. and T.S.; writing, original draft: A.K.M.M.I.; visualization: A.K.M.M.I.; manuscript review and editing: T.S., M.P.A., A.S.J. and H.K.-N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data sharing is not applicable, as no new data were generated or analyzed during this study.

Acknowledgments: The authors extend their appreciation to the financial support (to cover APC) provided by Adriano Sofo of University of Basilicata and Fabrizio Araniti of University Mediterranea of Reggio Calabria, Italy to the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Rice, E.L. *Allelopathy*; Academic Press: Orlando, FL, USA, 1984.
2. Weir, T.L.; Park, S.W.; Vivanco, J.M. Biochemical and physiological mechanisms mediated by allelochemicals. *Curr. Opin. Plant Biol.* **2004**, *7*, 472–479. [[CrossRef](#)] [[PubMed](#)]
3. Mirmostafae, S.; Azizi, M.; Fujii, Y. Study of allelopathic interaction of essential oils from medicinal and aromatic plants on seed germination and seedling growth of lettuce. *Agronomy* **2020**, *10*, 163. [[CrossRef](#)]
4. Putnam, A.R.; Tang, C.S. Allelopathy: State of the science. In *The Science of Allelopathy*; Putnam, A.R., Tang, C.S., Eds.; John Wiley & Sons: Hoboken, NJ, USA, 1986; pp. 1–19.
5. Islam, A.K.M.M.; Yeasmin, S.; Qasem, J.R.S.; Juraimi, A.S.; Anwar, M.P. Allelopathy of medicinal plants: Current status and future prospects in weed management. *Agric. Sci.* **2018**, *9*, 1569–1588. [[CrossRef](#)]
6. Shrestha, A.; Anwar, M.P.; Islam, A.K.M.M.; Gurung, T.; Dhakal, S.; Tanveer, A.; Javaid, M.M.; Nadeem, M.; Ikram, N.A. Weed science as a new discipline and its status in some South Asian universities and colleges: Examples from Bangladesh, Bhutan, Nepal and Pakistan. *CAB Rev.* **2021**, *16*, 1–14. [[CrossRef](#)]
7. Damalas, C.A.; Eleftherohorinos, I.G. Pesticide exposure, safety issues, and risk assessment indicators. *Int. J. Environ. Res. Pub. Health* **2011**, *8*, 1402–1419. [[CrossRef](#)]
8. Kortekamp, A. Unexpected side effects of herbicides: Modulation of plant-pathogen interactions. In *Herbicides and Environment*; Kortekamp, A., Ed.; Intech: London, UK, 2011; pp. 85–104. [[CrossRef](#)]

9. Marin-Morales, M.A.; Ventura-Camargo, B.C.; Hoshina, M.M. Toxicity of herbicides: Impact on aquatic and soil biota and human health. In *Herbicides-Current Research and Case Studies in Use*; Price, A.J., Kelton, J.A., Eds.; IntechOpen: London, UK, 2013; pp. 399–443. [[CrossRef](#)]
10. Heap, I. The International Herbicide-Resistant Weed Database. 2022. Available online: www.weedscience.org (accessed on 15 February 2022).
11. Sparks, T.C.; Hahn, D.R.; Garizi, N.V. Natural products, their derivatives, mimics and synthetic equivalents: Role in agrochemical discovery. *Pest Manag. Sci.* **2017**, *73*, 700–715. [[CrossRef](#)]
12. Das, C.; Dey, A.; Bandyopadhyay, A. Allelochemicals: An emerging tool for weed management. In *Evidence based Validation of Traditional Medicines*; Mandal, S.C., Chakraborty, R., Sen, S., Eds.; Springer: Singapore, 2021. [[CrossRef](#)]
13. Islam, A.K.M.M.; Widhalm, J.R. Agricultural uses of juglone: Opportunities and challenges. *Agronomy* **2020**, *10*, 1500. [[CrossRef](#)]
14. Nieto, G. Biological activities of three essential oils of the Lamiaceae family. *Medicines* **2017**, *4*, 63. [[CrossRef](#)]
15. Uritu, C.M.; Mihai, C.T.; Stanciu, G.D.; Dodi, G.; Alexa-Stratulat, T.; Luca, A.; Leon-Constantin, M.M.; Stefanescu, R.; Bild, V.; Melnic, S.; et al. Medicinal plants of the family Lamiaceae in pain therapy: A review. *Pain Res. Manag.* **2018**, *2018*, 7801543. [[CrossRef](#)]
16. Rendle, A.B. Volume II Dicotyledonous. In *The Classification of Flowering Plants*; Cambridge University Press: Cambridge, UK, 1959.
17. Stankovic, M. *Lamiaceae Species*; MDPI: Basel, Switzerland, 2020.
18. Chancellor, R.J. Experiments on the chemical control of emergent water plants. In Proceedings of the 5th British Weed Control Conference, Brighton, UK, 7–11 November 1960; p. 9.
19. Volf, F. Weed associations in Western Bohemia. In *Sbornik Vysoka Skala Zemedeloka v Praze Provozne Ekonomické Faculty v Ceskych Budejovicich Biologická Rada*; FAO: Rome, Italy, 1965; pp. 27–35.
20. Farnsworth, N.R.; Blomster, R.N.; Quimby, M.W.; Schermerhorn, J.W. *A Bibliography of Phytochemistry. The Lynn Index, Monograph VI*; University of Pittsburgh: Pittsburgh, PA, USA, 1969.
21. Lovett, J.V.; Weerakoon, W.L. Weed characteristics of the Labiatae, with special reference to allelopathy. *Biol. Agric. Hortic.* **1983**, *1*, 145–158. [[CrossRef](#)]
22. Islam, M.A.; Ahmed, F.; Das, A.K.; Bachar, S.C. Analgesic and anti-inflammatory activity of *Leonurus sibiricus*. *Fitoterapia* **2005**, *76*, 359–362. [[CrossRef](#)] [[PubMed](#)]
23. Rahmatullah, M.; Das, A.K.; Mollik, M.A.H.; Jahan, R.; Khan, M.; Rahman, T.; Chowdhury, M.H. An ethno medicinal survey of Dhamrai sub-district in Dhaka district, Bangladesh. *Am.-Eurasian J. Sustain. Agric.* **2009**, *3*, 881–888.
24. Moreira, A.C.P.; de Lima, E.O.; Wanderley, P.A.; Carmo, E.S.; de Souza, E.L. Chemical composition and antifungal activity of *Hyptis suaveolens* L. Poit. leaves essential oil against *Aspergillus* species. *Braz. J. Microbiol.* **2010**, *41*, 28–33. [[CrossRef](#)] [[PubMed](#)]
25. Prajapati, M.; Patel, J.; Modi, K.; Shah, M. *Leucas aspera*: A review. *Pharmacogn. Rev.* **2010**, *4*, 85–87. [[CrossRef](#)] [[PubMed](#)]
26. Holm, L.G.; Pancho, J.V.; Herberger, J.P.; Plucknett, D.L. *A Geographical Atlas of World Weeds*; John Wiley and Sons: New York, NY, USA, 1979.
27. Muller, W.H.; Lorber, P.; Haley, B.; Johnson, K. Volatile growth inhibitors produced by *Salvia leucophylla*: Effect on oxygen uptake by mitochondrial suspensions. *Bull. Torrey Bot. Club* **1969**, *96*, 89–96. [[CrossRef](#)]
28. Benchaa, S.; Hazzit, M.; Nadjia, Z.; Abdelkrim, H. Chemical composition and herbicidal activity of essential oils from two Labiatae species from Algeria. *J. Essent. Oil Res.* **2019**, *31*, 335–346. [[CrossRef](#)]
29. Araniti, F.; Lupini, A.; Mercati, F.; Statti, G.A.; Abenavoli, M.R. *Calamintha nepeta* L. (Savi) as source of phytotoxic compounds: Bio-guided fractionation in identifying biological active molecules. *Acta Physiol. Plant.* **2013**, *35*, 1979–1988. [[CrossRef](#)]
30. Islam, A.K.M.M.; Ohno, O.; Suenaga, K.; Kato-Noguchi, H. Two novel phytotoxic substances from *Leucas aspera*. *J. Plant Physiol.* **2014**, *171*, 877–883. [[CrossRef](#)]
31. De Mastro, G.; Fracchiolla, M.; Verdini, L.; Montemurro, P. Oregano and its potential use as bioherbicide. *Acta Hort.* **2006**, *723*, 335–346. [[CrossRef](#)]
32. Islam, A.K.M.M.; Ohno, O.; Suenaga, K.; Kato-Noguchi, H. Suaveolic acid: A potent phytotoxic substance of *Hyptis Suaveolens*. *Sci. World J.* **2014**, *2014*, 425942. [[CrossRef](#)]
33. Hazrati, H.; Saharkhiz, M.J.; Niakousari, M.; Moein, M. Natural herbicide activity of *Satureja hortensis* L. essential oil nanoemulsion on the seed germination and morphophysiological features of two important weed species. *Ecotoxicol. Environ. Saf.* **2017**, *142*, 423–430. [[CrossRef](#)] [[PubMed](#)]
34. Hazrati, H.; Saharkhiz, M.J.; Moein, M.; Khoshghalb, H. Phytotoxic effects of several essential oils on two weed species and Tomato. *Biocatal. Agric. Biotechnol.* **2018**, *13*, 204–212. [[CrossRef](#)]
35. Kordali, S.; Tazegul, A.; Cakir, A. Phytotoxic effects of *Nepeta meyeri* Benth. extracts and essential oil on seed germinations and seedling growths of four weed species. *Rec. Nat. Prod.* **2015**, *9*, 404–418.
36. Alipour, M.; Saharkhiz, M.J. Phytotoxic activity and variation in essential oil content and composition of Rosemary (*Rosmarinus officinalis* L.) during different phenological growth stages. *Biocatal. Agric. Biotechnol.* **2016**, *7*, 271–278. [[CrossRef](#)]
37. Atak, M.; Mavi, K.; Uremis, I. Bio-herbicidal effects of oregano and rosemary essential oils on germination and seedling growth of bread wheat cultivars and weeds. *Rom. Biotechnol. Lett.* **2016**, *21*, 11149–11158.
38. Alipour, M.; Saharkhiz, M.J.; Niakousari, M.; Seidi, D.M. Phytotoxicity of encapsulated essential oil of rosemary on germination and morphophysiological features of amaranth and radish seedlings. *Sci. Hortic.* **2019**, *243*, 131–139. [[CrossRef](#)]

39. El Mahdi, J.; Tarraf, W.; Ruta, C.; Piscitelli, L.; Aly, A.; De Mastro, G. Bio-herbicide potential of the essential oils from different *Rosmarinus officinalis* L. chemotypes in laboratory assays. *Agronomy* **2020**, *10*, 775. [[CrossRef](#)]
40. Kato-Noguchi, H. Phytotoxic substances involved in Teak allelopathy and agroforestry. *Appl. Sci.* **2021**, *11*, 3314. [[CrossRef](#)]
41. De Pasquale, C.; La Bella, S.; Cammalleri, I.; Gennaro, M.C.; Licata, M.; Leto, C.; Tuttolomondo, T. Agronomical and postharvest evaluation of the essential oils of Sicilian rosemary (*Rosmarinus officinalis* L.) biotypes. *Acta Hort.* **2019**, *1255*, 139–144. [[CrossRef](#)]
42. De Mastro, G.; Tarraf, W.; Verdini, L.; Brunetti, G.; Ruta, C. Essential oil diversity of *Origanum vulgare* L. populations from Southern Italy. *Food Chem.* **2017**, *235*, 1–6. [[CrossRef](#)]
43. Carrubba, A.; Abbate, L.; Sarno, M.; Sunseri, F.; Mauceri, A.; Lupini, A.; Mercati, F. Characterization of 549 Sicilian rosemary (*Rosmarinus officinalis* L.) germplasm through a multidisciplinary approach. *Planta* **2020**, *251*, 37. [[CrossRef](#)] [[PubMed](#)]
44. Baricevic, D.; Sosa, S.; Della, L.R.; Tubaro, A.; Simonovska, B.; Krasna, A.; Zupancic, A. Topical anti-inflammatory activity of *Salvia officinalis* L. leaves: The relevance of ursolic acid. *J. Ethnopharmacol.* **2001**, *75*, 125–132. [[CrossRef](#)]
45. Delamare, A.P.L.; Moschen-Pistorello, I.T.; Artico, L.; Atti-Serafini, L.; Echeverrigaray, S. Antibacterial activity of the essential oils of *Salvia officinalis* L. and *Salvia triloba* L. cultivated in South Brazil. *Food Chem.* **2007**, *100*, 603–608. [[CrossRef](#)]
46. Bouajaj, S.; Benyamna, A.; Bouamama, H.; Romane, A.; Falconieri, D.; Piras, A.; Marongiu, B. Antibacterial, allelopathic and antioxidant activities of essential oil of *Salvia officinalis* L. growing wild in the atlas mountains of Morocco. *Nat. Prod. Res.* **2013**, *27*, 1673–1676. [[CrossRef](#)]
47. Wu, Y.B.; Ni, Z.Y.; Shi, Q.W.; Dong, M.; Kiyota, H.; Gu, Y.C.; Cong, B. Constituents from *Salvia* species and their biological activities. *Chem. Rev.* **2012**, *112*, 5967–6026. [[CrossRef](#)]
48. Jamila, N.; Ullah, R.; Alwahsh, M.A.A.; Haider, S.; Wong, K.C.; Ullah, Z. Secondary metabolites from *Nepeta juncea*. *Afri. J. Biotechnol.* **2011**, *10*, 17884–17886. [[CrossRef](#)]
49. Bhat, A.H.; Alia, A.; Kumar, B.; Mubashir, S. Phytochemical Constituents of Genus *Nepeta*. *Res. Rev. J. Chem.* **2018**, *7*, 31–37.
50. Shakeri, A.; Khakdan, F.; Soheili, V.; Sahebkar, A.; Rassam, G.; Asili, J. Chemical composition, antibacterial activity, and cytotoxicity of essential oil from *Nepeta ucrainica* L. spp. *Kopetdagensis*. *Ind. Crops Prod.* **2014**, *58*, 315–321. [[CrossRef](#)]
51. Skorić, M.; Gligorijević, N.; Čavić, M.; Todorović, S.; Janković, R.; Ristić, M.; Mišić, D.; Radulović, S. Cytotoxic activity of *Nepeta rtanjensis* Diklić & Milojević essential oil and its mode of action. *Ind. Crops Prod.* **2017**, *100*, 163–170. [[CrossRef](#)]
52. Süntar, I.; Nabavi, S.M.; Barreca, D.; Fischer, N.; Efferth, T. Pharmacological and chemical features of *Nepeta* L. genus: Its importance as a therapeutic agent. *Phytother. Res.* **2018**, *32*, 185–198. [[CrossRef](#)]
53. Salehi, B.; Valussi, M.; Jugran, A.K.; Martorell, M.; Ramírez-Alarcón, K.; Stojanović-Radić, Z.Z.; Antolak, H.; Kęrgiel, D.; Mileski, K.S.; Sharifi-Rad, M.; et al. *Nepeta* species: From farm to food applications and phytotherapy. *Trends Food Sci. Technol.* **2018**, *80*, 104–122. [[CrossRef](#)]
54. Pattanayak, P.; Behera, P.; Das, D.; Panda, S. *Ocimum Sanctum* Linn. A reservoir plant for therapeutic applications: An overview. *Pharmacog. Rev.* **2010**, *4*, 95–105. [[CrossRef](#)] [[PubMed](#)]
55. Kothari, S.K.; Bhattacharya, A.K.; Ramesh, S. Essential oil yield and quality of methyl eugenol rich *Ocimum tenuiflorum* L.f. (syn. *O. sanctum* L.) grown in south India as influenced by method of harvest. *J. Chromatogr. A* **2004**, *1054*, 67–72. [[CrossRef](#)] [[PubMed](#)]
56. Kothari, S.K.; Bhattacharya, A.K.; Ramesh, S.; Garg, S.N.; Khanuja, S.P.S. Volatile constituents in oil from different plant parts of methyl eugenol-rich *Ocimum tenuiflorum* L.F. (Syn. *O. sanctum* L.) grown in south India. *J. Essent. Oil Res.* **2005**, *17*, 656–658. [[CrossRef](#)]
57. Koulivand, P.H.; Ghadiri, M.K.; Gorji, A. Lavender and the Nervous System. *Evid. Based Complement. Altern. Med.* **2013**, *2013*, 681304. [[CrossRef](#)]
58. Détár, E.; Németh, É.Z.; Gosztola, B.; Demján, I.; Pluhár, Z. Effects of variety and growth year on the essential oil properties of lavender (*Lavandula angustifolia* Mill.) and Lavandin (*Lavandula x Intermedia* Emeric Ex Loisel.). *Biochem. Syst. Ecol.* **2020**, *90*, 104020. [[CrossRef](#)]
59. Prusinowska, R.; Śmigielski, K.B. Composition, biological properties and therapeutic effects of lavender (*Lavandula angustifolia* L.). A review. *Herba Pol.* **2014**, *60*, 56–66. [[CrossRef](#)]
60. Woronuk, G.; Demissie, Z.; Rheault, M.; Mahmoud, S. Biosynthesis and therapeutic properties of *Lavandula* essential oil constituents. *Planta Med.* **2011**, *77*, 7–15. [[CrossRef](#)]
61. Wunderlin, R.P.; Hansen, B.F. *Atlas of Florida Vascular Plants*; University of South Florida: Tampa, FL, USA, 2008.
62. Bakkali, F.; Averbeck, S.; Averbeck, D.; Idaomar, M. Biological effects of essential oils—A review. *Food Chem. Toxicol.* **2008**, *46*, 446–475. [[CrossRef](#)]
63. Tyagi, A.K.; Malik, A. Antimicrobial action of essential oil vapours and negative air ions against *Pseudomonas fluorescens*. *Int. J. Food Microbiol.* **2010**, *143*, 205–210. [[CrossRef](#)]
64. Tyagi, A.K.; Malik, A. Liquid and vapour-phase antifungal activities of selected essential oils against *Candida albicans*: Microscopic observations and chemical characterization of *Cymbopogon citratus*. *BMC Complement. Med. Ther.* **2010**, *10*, 65. [[CrossRef](#)] [[PubMed](#)]
65. Perveen, K.; Haseeb, A.; Shukla, P.K. Effect of *Sclerotinia sclerotiorum* on the disease development, growth, oil yield and biochemical changes in plants of *Mentha arvensis*. *Saudi J. Biol. Sci.* **2010**, *17*, 291–294. [[CrossRef](#)] [[PubMed](#)]
66. Khan, R.A.; Khan, F.; Ahmed, M.; Shah, A.S.; Khan, N.A.; Khan, M.R.; Shah, M.S. Phytotoxic and antibacterial assays of crude methanolic extract of *Mentha longifolia* (Linn.). *Afr. J. Pharm. Pharmacol.* **2011**, *5*, 1530–1533. [[CrossRef](#)]

67. Kumar, P.; Mishra, S.; Malik, A.; Satya, S. Insecticidal properties of mentha Species: A review. *Ind. Crops Prod.* **2011**, *34*, 802–817. [[CrossRef](#)]
68. Zhao, D.; Xu, Y.W.; Yang, G.L.; Husaini, A.M.; Wu, W. Variation of essential oil of *Mentha haplocalyx* Briq. and *Mentha spicata* L. from China. *Ind. Crops Prod.* **2013**, *42*, 251–260. [[CrossRef](#)]
69. Borugă, O.; Jianu, C.; Mișcă, C.; Golet, I.; Gruia, A.T.; Horhat, F.G. *Thymus vulgaris* essential oil: Chemical composition and antimicrobial activity. *J. Med. Life* **2014**, *7*, 56–60.
70. Mandal, S.; DebMandal, M. Thyme (*Thymus vulgaris* L.) oils. In *Essential Oils in Food Preservation, Flavor and Safety*; Preedy, V.R., Ed.; Elsevier Inc.: Amsterdam, The Netherlands, 2016; pp. 825–834.
71. Purcell, S.C.; Pande, P.; Lin, Y.; Rivera, E.J.; Latisha, P.U.; Smallwood, L.M.; Kerstiens, G.A.; Armstrong, L.B.; Robak, M.T.; Baranger, A.M.; et al. Extraction and antibacterial properties of Thyme leaf extracts: Authentic practice of green chemistry. *J. Chem. Educ.* **2016**, *93*, 1422–1427. [[CrossRef](#)]
72. Salehi, B.; Mishra, A.P.; Shukla, I.; Sharifi-Rad, M.; Contreras, M.M.; Segura-Carretero, A.; Fathi, H.; Nasrabadi, N.N.; Kobarfard, F.; Sharifi-Rad, J. Thymol, thyme, and other plant sources: Health and potential uses. *Phytother. Res.* **2018**, *32*, 1688–1706. [[CrossRef](#)]
73. Imelouane, B.; Amhamdi, H.; Wathélet, J.P.; Ankit, M.; Khedid, K.E.L.; Bachiri, A. Chemical composition and antimicrobial activity of essential oil of Thyme (*Thymus Vulgaris*) from Eastern Morocco Synthèse et Caractérisation Des Nouveaux Hydrogels à Base de La Cellulose Pour l'Encapsulation de La Curcumine View Project Valorisation of Ar. *Int. J. Agric. Biol.* **2009**, *11*, 205–208.
74. Jarić, S.; Mitrović, M.; Pavlović, P. Review of ethnobotanical, phytochemical, and pharmacological study of *Thymus serpyllum* L. *Evid. Based Complement. Altern. Med.* **2015**, *2015*, 101978. [[CrossRef](#)]
75. Afolayan, A. Germination and growth features of seed of different sizes in *Hyptis suaveolens* (L.) Poit. *Range Manag. Agrofor.* **1993**, *14*, 139–145.
76. Barbosa, L.C.A.; Martins, F.T.; Teixeira, R.R.; Polo, M.; Montanari, R.M. Chemical variability and biological activities of volatile oils from *Hyptis suaveolens* (L.) Poit. *Agric. Conspec. Sci.* **2013**, *78*, 1–10.
77. Padalia, H.; Kudrat, M.; Sharma, K.P. Mapping sub-pixel occurrence of an alien invasive *Hyptis suaveolens* (L.) Poit. Using spectral unmixing technique. *Int. J. Remote Sens.* **2013**, *34*, 325–340. [[CrossRef](#)]
78. Islam, A.K.M.M.; Kato-Noguchi, H. Plant growth inhibitory activity of medicinal plant *Hyptis suaveolens*: Could allelopathy be a cause? *Em. J. Food Agric.* **2013**, *25*, 692–701. [[CrossRef](#)]
79. Das, S.N.; Patro, V.J.; Dinda, S.C. A review: Ethnobotanical survey of genus *Leucas*. *Pharmacog. Rev.* **2012**, *6*, 100–106. [[CrossRef](#)]
80. Nirmala, K.A.; Kanchana, M. *Leucas aspera*—A review of its biological activity. *Syst. Rev. Pharm.* **2018**, *9*, 41–44. [[CrossRef](#)]
81. Tasdemir, D.; Wright, A.D.; Sticher, O.; Linden, A. Detailed ¹H- and ¹³C-NMR investigations of some diterpenes isolated from *Leonurus persicus*. *J. Nat. Prod.* **1995**, *58*, 543. [[CrossRef](#)]
82. Ahmed, F.; Islam, M.A.; Rahman, M.M. Antibacterial activity of *Leonurus sibiricus* aerial parts. *Fitoterapia* **2006**, *77*, 316–317. [[CrossRef](#)]
83. Shin, H.Y.; Kim, S.H.; Kang, S.M.; Chang, I.J.; Kim, S.Y.; Jeon, H.; Leem, K.H.; Park, W.H.; Lim, J.P.; Shin, T.Y. Anti-inflammatory activity of motherwort (*Leonurus sibiricus* L.). *Immunopharmacol. Immunotoxicol.* **2009**, *31*, 209–213. [[CrossRef](#)]
84. Sitarek, P.; Rijo, P.; Garcia, C.; Skala, E.; Kalemba, D.; Białas, A.J.; Szemraj, J.; Pytel, D.; Toma, M.; Wysokińska, H.; et al. Antibacterial, anti-inflammatory, antioxidant, and antiproliferative properties of essential oils from hairy and normal roots of *Leonurus sibiricus* L. and their chemical composition. *Oxidative Med. Cell. Longev.* **2017**, *2017*, 7384061. [[CrossRef](#)]
85. Wu, H.; Fronczek, F.R.; Ferreira, D.; Burandt, C.L.; Zjawiony, J.K. Labdane diterpenoids from *Leonurus sibiricus*. *J. Nat. Prod.* **2011**, *74*, 831–836. [[CrossRef](#)] [[PubMed](#)]
86. Kordali, S.; Cakir, A.; Ozer, H.; Cakmakci, R.; Kesdek, M.; Mete, E. Antifungal, phytotoxic and insecticidal properties of essential oil isolated from Turkish *Origanum acutidens* and its three components, carvacrol, thymol and p-cymene. *Bioresour. Technol.* **2008**, *99*, 8788–8795. [[CrossRef](#)] [[PubMed](#)]
87. García-Beltrán, J.M.; Esteban, M.A. Properties and applications of plants of *Origanum* Sp. Genus. *SM J. Biol.* **2016**, *2*, 1006.
88. Coccimiglio, J.; Alipour, M.; Jiang, Z.H.; Gottardo, C.; Suntres, Z. Antioxidant, antibacterial, and cytotoxic activities of the ethanolic *Origanum vulgare* extract and its major constituents. *Oxidative Med. Cell. Longev.* **2016**, *2016*, 1404505. [[CrossRef](#)] [[PubMed](#)]
89. Chen, F.; Peng, S.; Chen, B.; Ni, G.; Liao, H. Allelopathic potential and volatile compounds of *Rosmarinus officinalis* L. against weeds. *Allelopath. J.* **2013**, *32*, 57–66.
90. Caputo, L.; Trotta, M.; Romaniello, A.; De Feo, V. Chemical composition and phytotoxic activity of *Rosmarinus officinalis* essential oil. *Nat. Prod. Commun.* **2018**, *13*, 1367–1370. [[CrossRef](#)]
91. Turill, W.B. The Genus *Rosmarinus*. *Bull. Misc. Inform.* **1920**, *1920*, 105–108. [[CrossRef](#)]
92. Džamić, A.M.; Soković, M.D.; Novaković, M.; Jadranin, M.; Ristić, M.S.; Tešević, V.; Marin, P.D. Composition, antifungal and antioxidant properties of *Hyssopus officinalis* L. Subsp. *Pilifer* (Pant.) Murb. essential oil and deodorized extracts. *Ind. Crops Prod.* **2013**, *51*, 401–407. [[CrossRef](#)]
93. Alinezhad, H.; Azimi, R.; Zare, M.; Ebrahimzadeh, M.A.; Eslami, S.; Nabavi, S.F.; Nabavi, S.M. Antioxidant and antihemolytic activities of ethanolic extract of flowers, leaves, and stems of *Hyssopus officinalis* L. Var. *Angustifolius*. *Int. J. Food Prop.* **2013**, *16*, 1169–1178. [[CrossRef](#)]

94. Fathiazad, F.; Hamedeyazdan, S. A review on *Hyssopus officinalis* L.: Composition and biological activities. *Afr. J. Pharm. Pharmacol.* **2011**, *5*, 1959–1966. [[CrossRef](#)]
95. Hikal, W.M.; Said-Al Ahl, H.A.H. Anti-Leishmanial activity of *Hyssopus Officinalis*: A review. *Int. J. Environ. Plan. Manag.* **2017**, *3*, 10–15.
96. Tahir, M.; Khushtar, M.; Fahad, M.; Rahman, M.A. Phytochemistry and pharmacological profile of traditionally used medicinal plant Hyssop (*Hyssopus officinalis* L.). *J. Appl. Pharm. Sci.* **2018**, *8*, 132–140. [[CrossRef](#)]
97. Venditti, A.; Bianco, A.; Frezza, C.; Conti, F.; Bini, L.M.; Giuliani, C.; Bramucci, M.; Quassinti, L.; Damiano, S.; Lupidi, G.; et al. Essential oil composition, polar compounds, glandular trichomes and biological activity of *Hyssopus officinalis* subsp. *Aristatus* (Godr.) Nyman from Central Italy. *Ind. Crops Prod.* **2015**, *77*, 353–363. [[CrossRef](#)]
98. Adam, Y.; Somchit, M.N.; Sulaiman, M.R.; Nasaruddin, A.A.; Zuraini, A.; Bustamam, A.A.; Zakaria, Z.A. Diuretic properties of *Orthosiphon stamineus* Benth. *J. Ethnopharmacol.* **2009**, *124*, 154–158. [[CrossRef](#)]
99. Ameer, O.Z.; Salman, I.M.; Asmawi, M.Z.; Ibraheem, Z.O.; Yam, M.F. *Orthosiphon Stamineus*: Traditional uses, phytochemistry, pharmacology, and toxicology. *J. Med. Food* **2012**, *15*, 678–690. [[CrossRef](#)]
100. Singh, M.K.; Gidwani, B.; Gupta, A.; Dhongade, H.; Kaur, C.D.; Kashyap, P.P.; Tripathi, D.K. A review of the medicinal plants of genus *Orthosiphon* (Lamiaceae). *Int. J. Biol. Chem.* **2015**, *9*, 318–331. [[CrossRef](#)]
101. Tezuka, Y.; Stampoulis, P.; Banskota, A.H.; Awale, S.; Tran, K.Q.; Saiki, I.; Kadota, S. Constituents of the Vietnamese medicinal plant *Orthosiphon stamineus*. *Chem. Pharm. Bull.* **2000**, *48*, 1711–1719. [[CrossRef](#)]
102. Bitchagno, G.T.M.; Sama Fonkeng, L.S.; Kopa, T.K.; Tala, M.F.; Wabo, H.K.; Tume, C.B.; Tane, P.; Kuate, J.R. Antibacterial activity of ethanolic extract and compounds from fruits of *Tectona grandis* (Verbenaceae). *BMC Complement. Med. Ther.* **2015**, *15*, 265. [[CrossRef](#)]
103. Ramesh, B.N.; Mahalakshmi, A.M. Pharmacology of *Tectona grandis* Linn.: Short review. *Int. J. Pharmacog. Phytochem. Res.* **2014**, *6*, 86–90.
104. Vyas, P.; Yadav, D.K.; Khandelwal, P. *Tectona grandis* (Teak)—A review on its phytochemical and therapeutic potential. *Nat. Prod. Res.* **2019**, *33*, 2338–2354. [[CrossRef](#)]
105. Jafari, F.; Ghavidel, F.; Zarshenas, M.M. A critical overview on the pharmacological and clinical aspects of popular *Satureja* species. *J. Acupunct. Meridian Stud.* **2016**, *9*, 118–127. [[CrossRef](#)] [[PubMed](#)]
106. Rustaiyan, A.; Feizbakhsh, A.; Masoudi, S.; Ameri, N. Comparison of the volatile oils of *Satureja atropatana* Bung. and *Satureja mutica* Fisch. et C.A. Mey. from Iran. *J. Essent. Oil Res.* **2004**, *16*, 594–596. [[CrossRef](#)]
107. Taban, A.; Saharkhiz, M.J.; Hadian, J. Allelopathic potential of essential oils from four *Satureja* spp. *Biol. Agric. Hortic.* **2013**, *29*, 244–257. [[CrossRef](#)]
108. Dosoky, N.S.; Moriarity, D.M.; Setzer, W.N. Phytochemical and biological investigations of *Conradina canescens*. *Nat. Prod. Commun.* **2016**, *11*, 25–28. [[CrossRef](#)]
109. Dosoky, N.S.; Setzer, W.N. The genus *Conradina* (Lamiaceae): A review. *Plants* **2018**, *7*, 19. [[CrossRef](#)]
110. CSIR. *The Useful Plants of India Industrial Research*; CSIR: New Delhi, India, 1992.
111. Khory, N.R.; Katrak, N.N. *Materia Medica of India and Their Therapeutics*; BDH Printers: New Delhi, India, 1999; p. 380.
112. Kumaran, A.; Karunakaran, R.J. Antioxidant and free radical scavenging activity of an aqueous extract of *Coleus aromaticus*. *Food Chem.* **2006**, *97*, 109–114. [[CrossRef](#)]
113. Khatun, S.; Chatterjee, N.C.; Cakilcioglu, U. Antioxidant activity of the medicinal plant *Coleus forskohlii* Briq. *Afr. J. Biotechnol.* **2011**, *10*, 2530–2535. [[CrossRef](#)]
114. Morton, J.F. Country borage (*Coleus ambonicus* Lour.): A potent flavoring and medicinal plant. *J. Herbs Spices Med. Plants* **1992**, *1*, 77. [[CrossRef](#)]
115. Paton, A.J.; Mwanyambo, M.; Govaerts, R.H.A.; Smitha, K.; Suddee, S.; Phillipson, P.B.; Wilson, T.C.; Forster, P.I.; Culham, A. Nomenclatural changes in *Coleus* and *Plectranthus* (Lamiaceae): A tale of more than two genera. *PhytoKeys* **2019**, *129*, 1–158. [[CrossRef](#)]
116. Wadikar, D.D.; Patki, P.E. *Coleus aromaticus*: A therapeutic herb with multiple potentials. *J. Food Sci. Technol.* **2016**, *53*, 2895–2901. [[CrossRef](#)]
117. Božović, M.; Ragno, R. *Calamintha nepeta* (L.) Savi and its main essential oil constituent pulegone: Biological activities and chemistry. *Molecules* **2017**, *22*, 290. [[CrossRef](#)] [[PubMed](#)]
118. Khodja, N.K.; Boulekbache, L.; Chegdani, F.; Dahmani, K.; Bennis, F.; Madani, K. Chemical composition and antioxidant activity of phenolic compounds and essential oils from *Calamintha nepeta* L. *J. Complement. Integr. Med.* **2018**, *15*, 1–12. [[CrossRef](#)] [[PubMed](#)]
119. Willis, R.J. *The History of Allelopathy*; Springer: Dordrecht, The Netherlands, 2007.
120. Muller, C.H.; Muller, W.H.; Haines, B.L. Volatile growth inhibitors produced by shrubs. *Science* **1964**, *143*, 471–473. [[CrossRef](#)] [[PubMed](#)]
121. Muller, C.H. The role of chemical inhibition (allelopathy) in vegetational composition. *Bull. Torrey Bot. Club* **1966**, *93*, 332–351. [[CrossRef](#)]
122. Bisio, A.; Fraternali, D.; Giacomini, M.; Giacomelli, E.; Pivetti, S.; Russo, E.; Caviglioli, G.; Romussi, G.; Ricci, D.; De Tommasi, D. Phytotoxicity of *Salvia* spp. exudates. *Crop Prot.* **2010**, *29*, 1434–1446. [[CrossRef](#)]

123. Rodríguez-Hahn, L.; Esquivel, B.; Cárdenas, J.; Ramamoorthy, T.P. The distribution of diterpenoids in *Salvia*. In *Advances in Labiatae Science*; Harley, R.M., Reynolds, T., Eds.; The Royal Botanic Gardens: Richmond, UK, 1992; pp. 335–347.
124. Erez, M.E.; Fidan, M. Allelopathic effects of Sage (*Salvia macrochlamys*) extract on germination of *Portulaca oleracea* seeds. *Allelopath. J.* **2015**, *35*, 285–296.
125. Bisio, A.; Damonte, G.; Fraternali, D.; Giacomelli, E.; Salis, A.; Romussi, G.; Cafaggi, S.; Ricci, D.; De Tommasi, N. Phytotoxic clerodane diterpenes from *Salvia miniata* Fernald (Lamiaceae). *Phytochemistry* **2011**, *72*, 265–275. [[CrossRef](#)]
126. Martino, L.D.; Roscigno, G.; Mancini, E.; De Falco, E.; De Feo, V. Chemical composition and antigerminative activity of the essential oils from five *Salvia* species. *Molecules* **2010**, *15*, 735–746. [[CrossRef](#)]
127. Nishida, N.; Tamotsu, S.; Nagata, N.; Saito, C.; Sakai, A. Allelopathic effects of volatile monoterpenoids produced by *Salvia leucophylla*: Inhibition of cell proliferation and DNA synthesis in the root apical meristem of *Brassica campestris* seedlings. *J. Chem. Ecol.* **2005**, *31*, 1187–1203. [[CrossRef](#)]
128. Sakai, A.; Yoshimura, H. Monoterpenes of *Salvia leucophylla*. *Curr. Bioact. Compd.* **2012**, *8*, 90–100. [[CrossRef](#)]
129. Khan, T.; Zahid, M.; Asim, M.; Shahzad-ul-Hussan; Iqbal, Z.; Choudhary, M.I.; Ahmad, V.U. Pharmacological activities of crude acetone extract and purified constituents of *Salvia moorcraftiana* Wall. *Phytomedicine* **2002**, *9*, 749–752. [[CrossRef](#)] [[PubMed](#)]
130. Šučur, J.; Popović, A.; Petrović, M.; Anačkov, G.; Malenčić, D.; Prvulović, D. Allelopathic effects and insecticidal activity of *Salvia sclarea* L. *Studia UBB Chem. LX* **2015**, *1*, 253–264.
131. Šučur, J.; Prvulović, D.; Anačkov, G.; Malenčić, D. Oxidative stress in bromus (*Bromus mollis* L.) seedlings treated with clary sage (*Salvia sclarea* L.) aqueous extract. *Biol. Nyssana* **2016**, *7*, 141–144. [[CrossRef](#)]
132. Rowshan, V.; Karimi, S. Essential oil composition and allelopathic affect of *Salvia macrosiphon* BOISS. on *Zea mays* L. *Int. J. Agric.* **2013**, *3*, 788.
133. Bajalan, I.; Zand, M.; Rezaee, S. Allelopathic effects of aqueous extract from *Salvia officinalis* L. on seed germination of barley and purslane. *Int. J. Agric. Crop Sci.* **2013**, *5*, 802–805.
134. Dragoeva, A.; Stoyanova, Z.; Koleva, V.; Dragolova, D. Allelopathic activity of *Nepeta nuda* L. subsp. *nuda* water extracts. *Acta Sci. Nat.* **2017**, *4*, 46–51. [[CrossRef](#)]
135. Mutlu, S.; Atici, O. Allelopathic effect of *Nepeta meyeri* Benth. extracts on seed germination and seedling growth of some crop plants. *Acta Physiol. Plant.* **2009**, *31*, 89–93. [[CrossRef](#)]
136. Jahan, N.; Israr, M.; Mansoor, A.; Yousafzai, A. Phytotoxicity of *Acropitilon repens* (Asteraceae) and *Nepeta pretervisa* (Laminaceae). *J. Appl. Emerg. Sci.* **2006**, *1*, 164–166.
137. Verma, S.K.; Kumar, S.; Pandey, V.; Verma, R.K.; Patra, D.D. Phytotoxic effects of sweet basil (*Ocimum basilicum* L.) extracts on germination and seedling growth of commercial crop plants. *Eur. J. Exp. Biol.* **2012**, *2*, 2310–2316.
138. Dafaallah, A.B.; Ahmed, S.A. Allelopathic effects of sweet Basil (*Ocimum basilicum* L.) on seed germination and seedling growth of some Poaceous crops. *Int. J. Environ. Agric. Biotechnol.* **2017**, *2*, 2629–2635. [[CrossRef](#)]
139. Ahmad, K.; Khalil, A.T.; Somayya, R. Antifungal, phytotoxic and hemagglutination activity of methanolic extracts of *Ocimum basilicum*. *J. Trad. Chin. Med.* **2016**, *36*, 794–798. [[CrossRef](#)]
140. Mekky, M.S.; Hassanien, A.M.A.; Kamel, E.M.; Ismail, A.E.A. Allelopathic effect of *Ocimum basilicum* L. extracts on weeds and some crops and its possible use as new crude bio-herbicide. *Ann. Agric. Sci.* **2019**, *64*, 211–221. [[CrossRef](#)]
141. Dafaallah, A.B.; Ahmed, S.A. Phytotoxic effects of Basil (*Ocimum basilicum* L.) aqueous extract on seed germination of some cereal crops. *Libyan J. Agric.* **2019**, *24*, 63–72.
142. Islam, A.K.M.M.; Kato-Noguchi, H. Phytotoxic activity of *Ocimum tenuiflorum* extracts on germination and seedling growth of different plant species. *Sci. World J.* **2014**, *2014*, 676242. [[CrossRef](#)] [[PubMed](#)]
143. Purohit, S.; Pandya, N. Allelopathic activity of *Ocimum sanctum* L. and *Tephrosia purpurea* (L.) Pers. leaf extracts on few common legumes and weeds. *Int. J. Res. Plant Sci.* **2013**, *3*, 5–9.
144. Akbarzadeh, M.; Bajalan, I.; Qalayi, E. Allelopathic effect of lavender (*Lavandula officinalis*) on seed germination of velvet flower and purslane. *Int. J. Agron. Plant Prod.* **2013**, *4*, 1285–1289.
145. Živković, M. Alelopatiski Utjecaj Vodenih Ekstrakata Lavandina (*Lavandula* X *Intermedia*). Ph.D. Thesis, Department of Plant Protection, Faculty of Agriculture, University of Osijek, Osijek, Croatia, 2017.
146. Haig, T.J.; Haig, T.J.; Seal, A.N.; Pratley, J.E.; An, M.; Wu, H. Lavender as a source of novel plant compounds for the development of a natural herbicide. *J. Chem. Ecol.* **2009**, *35*, 1129–1136. [[CrossRef](#)]
147. Politi, M.; Menghini, L.; Conti, B.; Bedini, S.; Farina, P.; Cioni, P.L.; Braca, A.; De Leo, M. Reconsidering hydrosols as main products of aromatic plants manufactory: The lavandin (*Lavandula* × *intermedia*) case study in Tuscany. *Molecules* **2020**, *25*, 2225. [[CrossRef](#)]
148. Mahdavia, F.; Saharkhiz, M.J.; Karami, A. Defensive response of radish seedlings to the oxidative stress arising from phenolic compounds in the extract of peppermint (*Mentha* × *piperita* L.). *Sci. Hortic.* **2017**, *214*, 133–140. [[CrossRef](#)]
149. Islam, A.K.M.M.; Kato-Noguchi, H. *Mentha sylvestris*: A potential allelopathic medicinal plant. *Int. J. Agric. Biol.* **2013**, *15*, 1313–1318.
150. Szafranec, R.; Mozdzeń, K.; Barabasz-Krasny, B.; Zandi, P.; Wang, Y. Influence of volatile peppermint (*Mentha* × *piperita* L.) compounds on germination and seedling of radish (*Raphanus sativus* L. var. *radicula* Pers.) growth. *Not. Bot. Horti Agrobot. Cluj-Napoca* **2019**, *47*, 1277–1284. [[CrossRef](#)]

151. Üstüner, T.; Kordali, Ş.; Bozhüyük, A.U. Herbicidal and fungicidal effects of *Cuminum cyminum*, *Mentha longifolia* and *Allium sativum* essential oils on some weeds and fungi. *Rec. Nat. Prod.* **2018**, *12*, 619–629. [[CrossRef](#)]
152. Maia, J.T.L.S.; Martins, E.R.; Costa, C.A.; Ferraz, E.O.F.; Alvarenga, I.C.A.; Souza Júnior, I.T.; Valadares, S.V. Influência do cultivo em consórcio na produção de fitomassa e óleo essencial de manjeriço (*Ocimum basilicum* L.) e hortelã (*Mentha x villosa* Huds.). *Rev. Bras. Plantas Med.* **2009**, *11*, 137–140. [[CrossRef](#)]
153. Azirak, S.; Karaman, S. Allelopathic effect of some essential oils and components on germination of weed species. *Acta Agric. Scand. B Soil Plant Sci.* **2008**, *58*, 88–92. [[CrossRef](#)]
154. Ateeq-ur-Rehman; Mannan, A.; Inayatullah, S.; Akhtar, M.Z.; Qayyum, M.; Mirza, B. Biological evaluation of wild thyme (*Thymus serpyllum*). *Pharm. Biol.* **2009**, *47*, 628–633. [[CrossRef](#)]
155. Ali, I.B.E.H.; Bahri, R.; Chaouachi, M.; Boussaïd, M.; Harzallah-Skhiri, F. Phenolic content, antioxidant and allelopathic activities of various extracts of *Thymus numidicus* Poir. organs. *Ind. Crops Prod.* **2014**, *62*, 188–195. [[CrossRef](#)]
156. Safari, H.; Tavili, A.; Saberi, M. Allelopathic effects of *Thymus kotschyanus* on seed germination and initial growth of *Bromus tomentellus* and *Trifolium repens*. *Front. Agric. China* **2010**, *4*, 475–480. [[CrossRef](#)]
157. Al-Hawas, G.H.S.; Azooz, M.M. Allelopathic potentials of *Artrmisia monosperma* and *Thymus vulgaris* on growth and physio-biochemical characteristics of pea seedlings. *Pak. J. Biol. Sci.* **2018**, *21*, 187–198. [[CrossRef](#)]
158. Lobiuc, A.; Boz, I.; Stratu, A.; Zamfirache, M. Preliminary aspects on the phytotoxicity of some thymus spp. aqueous extracts. *Analele Stiintifice ale Universitatii Alexandru Ioan Cuza din Iasi. Sect. II A Genet. Si Biol. Mol.* **2017**, *18*, 111–122.
159. Linhart, Y.B.; Keefover-Ring, K.; Mooney, K.A.; Breland, B.; Thompson, J.D. A chemical polymorphism in a multitrophic setting: Thyme monoterpene composition and food web structure. *Am. Nat.* **2005**, *166*, 517–529. [[CrossRef](#)]
160. Wang, L.; Deng, D.Y.; Tang, L.; Yuan, K.; Li, Y.X. Seed-germination and seedling-growth inhibition by aqueous extracts from *Hyptis rhomboidea*. In Proceedings of the 2015 International Conference on Industrial Technology and Management Science, Tianjin, China, 27–28 March 2015; Atlantis Press: Paris, France, 2015.
161. Rodrigues, A.C.; Artioli, F.A.; Polo, M.; Barbosa, L.C.A.; Beijo, L.A. Allelopathic effects of leaves of “bamburral” [*Hyptis suaveolens* (L.) poit.] on the germination of seeds of sorghum (*Sorghum vulgare* pers.), radish (*Raphanus sativus* L.) and lettuce (*Lactuca sativa* L.). *Rev. Bras. Plantas Med.* **2012**, *14*, 487–493. [[CrossRef](#)]
162. Patil, B.J.; Madane, A.N. Effect of *Hyptis suaveolens* (L.) Poit. and *Eupatorium odoratum* L. leaf extracts on seed mycoflora of legume plants. *Bio. Disc.* **2014**, *5*, 237–240.
163. Kumari, J.A.; Prasad, P. Assessing the allelopathy and autotoxicity effects of *Parthenium hysterophorus* L., *Senna uniflora* (Mill.) HS Irwin and Barneby and *Hyptis suaveolens* (L.) Poit. *Russ. J. Biol. Invasions* **2018**, *9*, 290–298. [[CrossRef](#)]
164. Maiti, P.; Bhakat, R.K.; Jha, Y.; Bhattacharjee, A. Allelopathic potential of *Hyptis suaveolens* on physiobiochemical changes of mung bean seeds. *Commun. Plant Sci.* **2015**, *5*, 67–75.
165. Joshi, N.; Joshi, A. Allelopathic effects of weed extracts on germination of wheat. *Ann. Plant Sci.* **2016**, *5*, 1330–1334. [[CrossRef](#)]
166. Nascimento, S.S.; Pereira, S.G.; Amorim, D.J.; Mendes, M.S.; Reis, I.S. Phytotoxicity of *Hyptis suaveolens* against soybean and lettuce crops. *Sci. Electron. Arch.* **2020**, *13*, 24–32. [[CrossRef](#)]
167. Arzoo, A.; Khatoon, A.; Nayak, S.K.; Mohapatra, A.; Satapathy, K.B. Assessment of the allelopathic potential of an invasive alien weed *Hyptis suaveolens* (L.) Poit. on germination of *Oryza sativa* L. *J. Food Sci. Eng.* **2016**, *6*, 212–214. [[CrossRef](#)]
168. Oraon, S.; Mondal, S. Allelopathic effect of Lamiaceae weeds on seed germination and early growth of aromatic rice (*Oryza sativa* ‘Gobindohog’). *Acta Agrobot.* **2021**, *74*, 741. [[CrossRef](#)]
169. Islam, A.K.M.M.; Kato-Noguchi, H. Allelopathic potentiality of medicinal plant *Leucas aspera*. *Int. J. Sust. Agric.* **2012**, *4*, 1–7.
170. Sayed, M.A.; Alam, M.A.; Islam, M.S.; Ali, M.T.; Ullah, M.E.; Shibly, A.Z.; Ali, M.A.; Hasan-Olive, M.M. *Leonurus sibiricus* L. (honeyweed): A review of its phytochemistry and pharmacology. *Assian Pac. J. Trop. Biomed.* **2016**, *6*, 1076–1080. [[CrossRef](#)]
171. Islam, A.K.M.M.; Kato-Noguchi, H. Allelopathic activity of *Leonurus sibiricus* on different target plant species. *J. Food Agric. Environ.* **2014**, *12*, 286–289.
172. Sayed, M.A.; Haque, M.M.; Roy, B.; Hossain, S.M.J.; Das, S.R. Allelopathic effects of different extracts of honeyweed (*Leonurus sibiricus*) on seeds germination and seedlings growth of some selected vegetables. *J. Nat. Prod.* **2012**, *5*, 243–250.
173. Dragoeva, A.P.; Nanova, Z.D.; Kalcheva, V.P. Allelopathic activity of micropropagated *Hyssopus officinalis* L., Lamiaceae, water infusions. *Rev. Bras. Farmacog.* **2010**, *20*, 513–518. [[CrossRef](#)]
174. Araniti, F.; Landi, M.; Lupini, A.; Sunseri, F.; Guidi, L.; Abenavoli, M.R. *Origanum vulgare* essential oils inhibit glutamate and aspartate metabolism altering the photorespiratory pathway in *Arabidopsis thaliana* seedlings. *J. Plant Physiol.* **2018**, *231*, 297–309. [[CrossRef](#)] [[PubMed](#)]
175. Altindal, N.; Altindal, D. Allelopathic effect of sage and Turkish oregano volatile oils on in vitro in sainfoin (*Onobrychis viciifolia*). *J. Essent. Oil Bear. Plants* **2013**, *16*, 328–333. [[CrossRef](#)]
176. Dragoeva, A.P.; Koleva, V.; Nanova, Z.D.; Kaschieva, M.Z.; Yotova, I.R. Allelopathic and cytotoxic activity of *Origanum vulgare* ssp. *vulgare* growing wild in Bulgaria. *Chem. Bulg. J. Sci. Educ.* **2014**, *23*, 914–924.
177. Dragoeva, A.P.; Koleva, V.P.; Nanova, Z.D.; Kaschieva, M.Z. Allelopathy of cold water extracts from *Origanum vulgare* ssp. *vulgare* L. *J. Agric. Chem. Environ.* **2014**, *3*, 144–150. [[CrossRef](#)]
178. Bonea, D.; Urechean, V. Effect of sweet marjoram (*Origanum majorana* L.) cogermination and aqueous extracts on maize (*Zea mays* L.). *Agric. Life Life Agric. Conf. Proceed.* **2018**, *1*, 11–16. [[CrossRef](#)]

179. Tebaa, L.; Douma, M.; Tazart, Z.; Manaut, N.; Mouhri, K.; Loudiki, M. Algicidal effects of *Achillea ageratum* L. and *Origanum compactum* benth. plant extracts on growth of *Microcystis aeruginosa*. *Appl. Ecol. Environ. Res.* **2017**, *15*, 719–728. [[CrossRef](#)]
180. Najem, A.M.; Abed, I.J.; Al-Haidari, A.M.D. Evaluation the activity of Rosemary (*Rosmarinus officinalis* L.) essential oil against some Cyanobacteria. *Iraqi J. Biotechnol.* **2016**, *15*, 97–102.
181. Ramezani, S.; Saharkhiz, M.J.; Ramezani, F.; Fotokian, M.H. Use of essential oils as bioherbicides. *J. Essent. Oil Bear. Plants* **2008**, *11*, 319–327. [[CrossRef](#)]
182. Santana-Méridas, O.; Polissiou, M.; Izquierdo-Melero, M.E.; Astraka, K.; Tarantilis, P.A.; Herraiz-Peñalver, D.; Sánchez-Vioque, R. Polyphenol composition, antioxidant and bioplaguicide activities of the solid residue from hydrodistillation of *Rosmarinus officinalis* L. *Ind. Crops Prod.* **2014**, *59*, 125–134. [[CrossRef](#)]
183. El-Kenany, E.T.; Fakhry, A.M. Phytotoxicity of *Rosmarinus officinalis* L. and *Salvia officinalis* L. to control the noxious weed, *Panicum turgidum* Forssk. *Egypt. J. Bot.* **2016**, *56*, 381–393. [[CrossRef](#)]
184. Saharkhiz, M.J.; Ashiri, F.; Salehi, M.R.; Ghaemghami, J.; Mohammadi, S. Allelopathic potential of essential oils from *Carum copticum* L., *Cuminum cyminum* L., *Rosmarinus officinalis* L. and *Zataria multiflora* Boiss. *Med. Aroma. Plant Sci. Biotechnol.* **2009**, *3*, 32–35.
185. Šučur, J.; Popović, A.; Petrović, M.; Anačkov, G.; Bursić, V.; Kiproviski, B.; Prvulović, D. Allelopathic effects and insecticidal activity of the aqueous extract of *Satureja montana* L. *J. Serbian Chem. Soc.* **2015**, *80*, 475–484. [[CrossRef](#)]
186. Masoud, M.; Abugarsa, M.A.O.S.A. Allelopathic effects of aqueous extract from *Satureja thymbra* L. on seed germination and seedling growth of *Pinus halepensis* Mill. and *Ceratonia siliqua* L. *Libyan J. Sci. Technol.* **2018**, *7*, 17–20.
187. Šučur, J.; Prvulović, D.; Manojlović, A.; Anačkov, G.; Malenčić, Đ. Influence of winter savory (*Satureja montana* L.) aqueous extract on antioxidant properties of Jimson weed (*Datura stramonium* L.). *Bot. Serbica* **2018**, *42*, 271–275. [[CrossRef](#)]
188. Šučur, J.; Prvulović, D.; Anačkov, G.; Malenčić, D. The effect of *Satureja montana* L. aqueous extract on soybean seedlings. *Biol. Nyssana* **2016**, *7*, 125–129.
189. Taban, A.; Saharkhiz, M.J. Natural phytotoxic activity of water extracts and dried leaf powders of three *Satureja* species. *Biocatal. Agric. Biotechnol.* **2015**, *4*, 594–602. [[CrossRef](#)]
190. Gholami, B.A.; Faravani, M.; Kashki, M.T. Allelopathic effects of aqueous extract from *Artemisia kopetdaghensis* and *Satureja hortensis* on growth and seed germination of weeds. *J. Appl. Environ. Biol. Sci.* **2011**, *1*, 283–290.
191. Kole, R.K.; Karmakar, P.R.; Poi, R.; Mazumdar, D. Allelopathic inhibition of teak leaf extract: A potential pre-emergent herbicide. *J. Crop Weed* **2011**, *7*, 101–109.
192. Manimegalai, A. Allelopathic effect of *Tectona grandis* leaves on protein content changes of black gram and green gram. *Int. J. Curr. Sci.* **2012**, *4*, 30–34.
193. Manimegalai, A.; Manikandan, A.; Sheela, R.; Geetha, S. Allelopathic influence of *Tectona grandis* leaves on the germination of black gram and green gram. *Int. J. Curr. Sci.* **2012**, *1*, 241–244.
194. Manimegalai, A. Allelopathic potential of *Tectona grandis* leaves extract on dry weight of *Vigna mungo* and *Vigna radiata*. *Int. J. Curr. Sci.* **2013**, *5*, 15–20.
195. Biswas, K.; Das, A.P. Allelopathic effects of teak (*Tectona grandis* L.f.) on germination and seedling growth of *Plumbago zeylanica* L. *Pleione* **2016**, *10*, 262–268.
196. da Silva, M.C.; Araujo, E.C.G.; Silva, T.C.; de Araujo, A.B.; da Silva Lins, T.R.; Leao, S.L.M.; de Lima, T.V. Alelopathic effects of *Tectona grandis* L.f. in the germination and initial development of Lettuce (*Lactuca sativa* L.). *J. Agric. Sci.* **2019**, *11*, 382–387. [[CrossRef](#)]
197. John, J.; Sreekumar, K.M.; Rekha, P. Allelopathic effects of leaf leachates of multipurpose trees on vegetables. *Allelopath. J.* **2007**, *19*, 507–516.
198. Evangeline, V.R.; Prakash, E.J.J.; Samuel, A.S.; Jayakumar, M. Allelopathic potential of *Tectona grandis* L. on the germination and seedling growth of *Vigna mungo* (L.) Hepper. *Pak. J. Weed Sci. Res.* **2012**, *18*, 65–70.
199. Mensah, E.E.; Owusu-Mensah, I.; Oppong, E.; Saka, M.O. Allelopathic effect of topsoil extract from *Tectona grandis* L. plantation on the germination of *Lycopersicon esculentum*. *J. Biol. Agric. Healthc.* **2015**, *5*, 117–122.
200. Kato-Noguchi, H.; Hamada, N.; Morita, M.; Suenaga, K. A novel allelopathic substance, 13-epi-orthosiphon N, in *Orthosiphon stamineus*. *J. Plant Physiol.* **2013**, *170*, 1–5. [[CrossRef](#)]
201. Araniti, F.; Lupini, A.; Sorgonà, A.; Statti, G.A.; Abenavoli, M.R. Phytotoxic activity of foliar volatiles and essential oils of *Calamintha nepeta* (L.) Savi. *Nat. Prod. Res.* **2013**, *27*, 1651–1656. [[CrossRef](#)] [[PubMed](#)]
202. Araniti, F.; Sorgonà, A.; Lupini, A.; Abenavoli, M.R. Screening of Mediterranean wild plant species for allelopathic activity and their use as bio-herbicides. *Allelopath. J.* **2011**, *29*, 107–124.
203. Gnanavel, L.; Kathiresan, R.M. Allelopathic potential of Coleus on water hyacinth. *Indian J. Weed Sci.* **2013**, *45*, 71–72.
204. Kathiresan, R.M. Allelopathic potential of native plants against water hyacinth. *Crop Prot.* **2000**, *19*, 705–708. [[CrossRef](#)]
205. Mandal, M.P.; Kumar, S.; Kumari, P.; Kiran. Allelopathic effects of medicinal plant species on seed germination and seedling growth of wheat varieties. *Curr. J. Appl. Sci. Technol.* **2018**, *31*, 1–7. [[CrossRef](#)]
206. Zhang, C.; Yi, Y.L.; Hao, K.; Liu, G.L.; Wang, G.X. Algicidal activity of *Salvia miltiorrhiza* Bung on *Microcystis aeruginosa*—Towards identification of algicidal substance and determination of inhibition mechanism. *Chemosphere* **2013**, *93*, 997–1004. [[CrossRef](#)]
207. Fraga, B.M.; Diaz, C.E.; Guadano, A.; Gonzalez-Coloma, A. Diterpenes from *Salvia broussonetii* transformed roots and their insecticidal activity. *J. Agric. Food Chem.* **2005**, *53*, 5200–5206. [[CrossRef](#)]

208. Eom, S.H.; Yang, H.S.; Weston, L.A. An Evaluation of the allelopathic potential of selected perennial groundcovers: Foliar volatiles of Catmint (*Nepeta × faassenii*) inhibit seedling growth. *J. Chem. Ecol.* **2006**, *32*, 1835–1848. [[CrossRef](#)]
209. Mutlu, S.; Atici, O.; Esim, N. Bioherbicidal effects of essential oils of *Nepeta meyeri* Benth. On weed spp. *Allelopath. J.* **2010**, *26*, 291–300.
210. Mutlu, S.; Atici, O.; Esim, N.; Mete, E. Essential oils of catmint (*Nepeta meyeri* Benth.) induce oxidative stress in early seedlings of various weed species. *Acta Physiol. Plant.* **2011**, *33*, 943–951. [[CrossRef](#)]
211. Mancini, E.; Arnold, N.A.; De Feo, V.; Formisano, C.; Rigano, D.; Piozzi, F.; Senatore, F. Phytotoxic effects of essential oils of *Nepeta curviflora* Boiss. and *Nepeta nuda* L. subsp. *albiflora* growing wild in Lebanon. *J. Plant Interact.* **2009**, *4*, 253–259. [[CrossRef](#)]
212. Kekeç, G.; Mutlu, S.; Alpsoy, L.; Sakçali, M.S.; Atici, O. Genotoxic effects of catmint (*Nepeta meyeri* Benth.) essential oils on some weed and crop plants. *Toxicol. Ind. Health* **2012**, *29*, 504. [[CrossRef](#)] [[PubMed](#)]
213. Bozok, F. Herbicidal activity of *Nepeta flavida* essential oil. *J. Essent. Oil Bear. Plants* **2018**, *21*, 1687–1693. [[CrossRef](#)]
214. Kobaisy, M.; Tellez, M.R.; Dayan, F.E.; Mamonov, L.K.; Mukanova, G.S.; Sitpaeva, G.T.; Gemejeva, N.G. Composition and phytotoxic activity of *Nepeta pannonica* L. essential oil. *J. Essent. Oil Res.* **2005**, *17*, 704–707. [[CrossRef](#)]
215. Filho, A.P.S.; Bayma, J.C.; Guilhon, G.M.S.P.; Zoghbi, M.G.B. Potentially allelopathic activity of the essential oil of *Ocimum americanum*. *Planta Daninha* **2009**, *27*, 499–505. [[CrossRef](#)]
216. Macdonald, I.O.; Oludare, A.S.; Olabiyi, A. Phytotoxic and anti-microbial activities of flavonoids in *Ocimum gratissimum*. *Life Sci. J.* **2010**, *7*, 45–48.
217. Koiou, K.; Vasilakoglou, I.; Dhima, K. Herbicidal potential of lavender (*Lavandula angustifolia* Mill.) essential oil components on bristly foxtail (*Setaria verticillata* (L.) P. Beauv.): Comparison with carvacrol, carvone, thymol and eugenol. *Arch. Biol. Sci.* **2020**, *72*, 223–231. [[CrossRef](#)]
218. Gitsopoulos, T.K.; Chatzopoulou, P.; Georgoulas, I. Effects of essential oils of *Lavandula × hybrida* Rev, *Foeniculum vulgare* Mill and *Thymus capitatus* L. on the germination and radical length of *Triticum aestivum* L., *Hordeum vulgare* L., *Lolium rigidum* L. and *Phalaris brachystachys* L. *J. Essent. Oil Bear. Plants* **2013**, *16*, 817–825. [[CrossRef](#)]
219. Masi, M.; Pannacci, E.; Santoro, E.; Zermane, N.; Superchi, S.; Evidente, A. Stoechanones A and B, Phytotoxic Copaane Sesquiterpenoids isolated from *Lavandula stoechas* with potential herbicidal activity against *Amaranthus retroflexus*. *J. Nat. Prod.* **2020**, *83*, 1658–1665. [[CrossRef](#)]
220. Singh, N.; Singh, H.P.; Batish, D.R.; Kohli, R.K.; Yadav, S.S. Chemical characterization, phytotoxic, and cytotoxic activities of essential oil of *Mentha longifolia*. *Environ. Sci. Pollut. Res.* **2020**, *27*, 13512–13523. [[CrossRef](#)]
221. Chauhan, S.S.; Prakash, O.; Padalia, R.C.; Vivekanand; Pant, A.K.; Mathela, C.S. Chemical diversity in *Mentha spicata*: Antioxidant and potato sprout inhibition activity of its essential oils. *Nat. Prod. Commun.* **2011**, *6*, 1373–1378. [[CrossRef](#)] [[PubMed](#)]
222. Grul'ová, D.; De Martino, L.; Mancini, E.; Tkáčiková, L.U.; Šalamon, I.; Fejer, J.; De Feo, V. Phytotoxic and antibacterial activity of essential oil of new peppermint cultivar. *Nat. Prod. Commun.* **2016**, *11*, 1721–1724. [[CrossRef](#)]
223. Ahmed, A.; Ayoub, K.; Chaima, A.J.; Hanaa, L.; Abdelaziz, C. Effect of drying methods on yield, chemical composition and bioactivities of essential oil obtained from Moroccan *Mentha pulegium* L. *Biocatal. Agric. Biotechnol.* **2018**, *16*, 638–643. [[CrossRef](#)]
224. Sarheed, M.M.; Rajabi, F.; Kunert, M.; Boland, W.; Wetters, S.; Miadowitz, K.; Kazmierczak, A.; Sahi, V.P.; Nick, P. Cellular base of mint allelopathy: Menthone affects plant microtubules. *Front. Plant Sci.* **2020**, *11*, 1320. [[CrossRef](#)]
225. Mahdavikia, F.; Saharkhiz, M.J. Phytotoxic activity of essential oil and water extract of peppermint (*Mentha × piperita* L. CV. Mitcham). *J. Appl. Res. Med. Plants* **2015**, *2*, 146–153. [[CrossRef](#)]
226. Mucciarelli, M.; Camusso, W.; Berteau, C.M.; Bossi, S.; Maffei, M. Effect of (+)-pulegone and other oil components of *Mentha × piperita* on cucumber respiration. *Phytochemistry* **2001**, *57*, 91–98. [[CrossRef](#)]
227. Ali, I.B.E.H.; Chaouachi, M.; Bahri, R.; Chaieb, I.; Boussaïd, M.; Harzallah-Skhiri, F. Chemical composition and antioxidant, antibacterial, allelopathic and insecticidal activities of essential oil of *Thymus algeriensis* Boiss. et Reut. *Ind. Crops Prod.* **2015**, *77*, 631–639. [[CrossRef](#)]
228. Saoud, I.; Hamrouni, L.; Gargouri, S.; Amri, I.; Hanana, M.; Fezzani, T.; Bouzid, S.; Jamoussi, B. Chemical composition, weed killer and antifungal activities of Tunisian thyme (*Thymus capitatus* Hoff. et Link.) essential oils. *Acta Aliment.* **2013**, *42*, 417–427. [[CrossRef](#)]
229. Kashkooli, A.B.; Saharkhiz, M.J. Essential oil compositions and natural herbicide activity of four Denaei Thyme (*Thymus daenensis* Celak.) ecotypes. *J. Essent. Oil Bear. Plants* **2014**, *17*, 859–874. [[CrossRef](#)]
230. Saleh, I.; Abd-ElGawad, A.; El Gendy, A.E.N.; Abd El Aty, A.; Mohamed, T.; Kassem, H.; Aldosri, F.; Elshamy, A.; Hegazy, M.E.F. Phytotoxic and antimicrobial activities of *Teucrium polium* and *Thymus decussatus* essential oils extracted using hydrodistillation and microwave-assisted techniques. *Plants* **2020**, *9*, 716. [[CrossRef](#)]
231. Giweli, A.; Said, A.; Aoun, T.; Elhaji, N. Allelopathic effects on seeds germination of *Lactuca sativa* L. seeds and antibacterial activity of *Thymus capitatus* essential oil from Zintan-Libya flora. *Am. Acad. Sci. Res. J. Engin. Technol. Sci.* **2016**, *17*, 121–131.
232. Ulukanli, Z.; Cenet, M.; Ince, H.; Yilmaztekin, M. Antimicrobial and herbicidal activities of the essential oil from the Mediterranean *Thymus eigi*. *J. Essent. Oil Bear. Plants* **2018**, *21*, 214–222. [[CrossRef](#)]
233. Grosso, C.; Figueiredo, A.C.; Burillo, J.; Mainar, A.M.; Urieta, J.S.; Barroso, J.G.; Coelho, J.A.; Palavra, A.M. Composition and antioxidant activity of *Thymus vulgaris* volatiles: Comparison between supercritical fluid extraction and hydrodistillation. *J. Sep. Sci.* **2010**, *33*, 2211–2218. [[CrossRef](#)] [[PubMed](#)]

234. Hemada, M.; El-Darier, S. Comparative study on composition and biological activity of essential oils of two *Thymus* species grown in Egypt. *Am.-Eurasian J. Agric. Environ. Sci.* **2011**, *11*, 647–654.
235. Mandal, S. Allelopathic activity of root exudates from *Leonurus sibiricus* L. (Raktodrone). *Weed Biol. Manag.* **2001**, *1*, 170–175. [[CrossRef](#)]
236. Almeida, L.F.R.; Delachieve, M.E.; Sannomiya, M.; Vilegas, W.; dos Santos, L.C.; Mancini, E.; De Feo, V. In vitro allelopathic potential of *Leonurus sibiricus* L. leaves. *J. Plant Interact.* **2008**, *3*, 39–48. [[CrossRef](#)]
237. Dudai, N.; Poljakoff-Mayber, A.; Mayer, A.M.; Putievsky, E.; Lerner, H.R. Essential oils as allelochemicals and their potential use as bioherbicides. *J. Chem. Ecol.* **1999**, *25*, 1079–1089. [[CrossRef](#)]
238. Bozari, S.; Agar, G.; Yanmis, D. Chemical content, and toxic effects of essential oil of *Origanum vulgare* L. ssp. *vulgare* against to *Zea mays* seedlings. *J. Essent. Oil Bear. Plants* **2014**, *17*, 67–77. [[CrossRef](#)]
239. Erbaş, S.; Karaman, R.; Baydar, H.; Şanlı, A. Allelopathic effect of oregano (*Origanum onites* L.) on germination and seedling development of some weed and cultivars. *Sci. Pap. Ser. A Agron.* **2015**, *58*, 190–194.
240. Fouad, R.; Bousta, D.; Lalami, A.E.O.; Chahdi, F.O.; Amri, I.; Jamoussi, B.; Greche, H. Chemical composition and herbicidal effects of essential oils of *Cymbopogon citratus* (DC) Stapf, *Eucalyptus cladocalyx*, *Origanum vulgare* L. and *Artemisia absinthium* L. cultivated in Morocco. *J. Essent. Oil Bear. Plants* **2015**, *18*, 112–123. [[CrossRef](#)]
241. Zhao, Y.; Yang, Y.H.; Wang, K.B.; Fan, L.M.; Su, F.W.; Ye, M. Chemical composition and allelopathic potential of essential oil isolated from *Origanum vulgare*. *J. Appl. Ecol.* **2020**, *31*, 2257–2263. [[CrossRef](#)]
242. Mancini, E.; Camele, I.; Elshafie, H.S.; De Martino, L.; Pellegrino, C.; Grulova, D.; De Feo, V. Chemical composition and biological activity of the essential oil of *Origanum vulgare* ssp. *hirtum* from different areas in the Southern Apennines (Italy). *Chem. Biodivers.* **2014**, *11*, 639–651. [[CrossRef](#)] [[PubMed](#)]
243. Yillar, M.; Bayar, Y.; Onaran, A. Chemical composition and allelopathic effect of *Origanum onites* L. essential oil. *Plant Prot. Bull.* **2019**, *59*, 71–78. [[CrossRef](#)]
244. Taban, A.; Saharkhiz, M.J.; Hooshmandi, M. Insecticidal and repellent activity of three *Satureja* species against adult red flour beetles, *Tribolium castaneum* (Coleoptera: Tenebrionidae). *Acta Ecol. Sin.* **2017**, *37*, 201–206. [[CrossRef](#)]
245. Macías, F.A.; Lacret, R.; Varela, R.M.; Nogueiras, C.; Molinillo, J.M.G. Isolation and phytotoxicity of terpenes from *Tectona grandis*. *J. Chem. Ecol.* **2010**, *36*, 396–404. [[CrossRef](#)]
246. Menelaou, M.A.; Henandez, H.P.; Macías, F.A.; Weidenhamer, J.D.; Williamson, G.B.; Fronczek, F.R.; Fischer, H.D.; Fischer, N.H. Constituents of *Calamintha ashei*: Effects on Florida sandhill species. *Nat. Prod. Commun.* **2010**, *5*, 685–694. [[CrossRef](#)]
247. Saharkhiz, M.J.; Zadnour, P.; Kakouei, F. Essential oil analysis and phytotoxic activity of catnip (*Nepeta cataria* L.). *Am. J. Essent. Oils Nat. Prod.* **2016**, *4*, 40–45.
248. Formisano, C.; Rigano, D.; Arnold, N.A.; Piozzi, F.; Senatore, F. GC and GC–MS analysis of the essential oil of *Nepeta cilicica* Boiss. ex Benth. from Lebanon. *Nat. Prod. Res.* **2013**, *27*, 1975–1981. [[CrossRef](#)]
249. Hussain, J.; Jamila, N.; Gilani, S.A.; Abbas, G.; Ahmed, S. Platelet aggregation, antiglycation, cytotoxic, phytotoxic and antimicrobial activities of extracts of *Nepeta juncea*. *Afr. J. Biotechnol.* **2009**, *8*, 935–940.
250. Bączek, K.; Kosakowska, O.; Gniewosz, M.; Gientka, I.; Węglarz, Z. Sweet basil (*Ocimum basilicum* L.) productivity and raw material quality from organic cultivation. *Agronomy* **2019**, *9*, 279. [[CrossRef](#)]
251. Culpeper, N. *Culpeper's English Physician and Complete Herbal*; Foulsham: London, UK, 1633; (Reprint 1955).
252. Samunder, S.; Megh, S. Interactions of Basil (*Ocimum sanctum* L.) with some weed species—Competition or allelopathy? *Indian J. Weed Sci.* **2009**, *41*, 12–22.
253. Mota, M.S.C.S.; Silva, R.S.; Silva, G.A.; Picanco, M.C.; Mesquita, A.L.M.; Pereira, R.C.A. Potential of allelochemicals from basil (*Ocimum micranthum* Willd) to control whitefly (*Aleurodicus cocois* (Curtis, 1846)) in cashew nut crop (*Anacardium occidentale* L.). *Allelopath. J.* **2017**, *40*, 197–208. [[CrossRef](#)]
254. Guitton, Y.; Nicolè, F.; Jullien, F.; Caissard, J.C.; Saint-Marcoux, D.; Legendre, L.; Pasquier, B.; Moja, S. A comparative study of terpene composition in different clades of the genus *Lavandula*. *Bot. Lett.* **2018**, *165*, 494–505. [[CrossRef](#)]
255. Passalacqua, N.G.; Tundis, R.; Upson, T.M. A new species of *Lavandula* Sect. *Lavandula* (Lamiaceae) and review of species boundaries in *Lavandula angustifolia*. *Phytotaxa* **2017**, *292*, 161–170. [[CrossRef](#)]
256. Barhouchi, B.; Aouadi, S.; Abdi, A. Comparative chemical profile of *Lavandula stoechas* L. essential oils isolated from flowers and leaves native to Algeria. *Phytothérapie* **2019**, *17*, 240–248. [[CrossRef](#)]
257. Müller, W.E.; Sillani, G.; Schuwald, A.; Friedland, K. Pharmacological basis of the anxiolytic and antidepressant properties of Silexan[®], an essential oil from the flowers of Lavender. *Neurochem. Int.* **2021**, *143*, 104899. [[CrossRef](#)]
258. Qasem, J.R. Allelopathic effects of selected medicinal plants on *Amaranthus retroflexus* and *Chenopodium murale*. *Allelopath. J.* **2002**, *10*, 105–122.
259. Dias, L.S.; Pereira, I.P.; Dias, A.S. Evaluation of Mediterranean-type vegetation for weedicide activity. *Allelopath. J.* **1995**, *2*, 197–204.
260. Argyropoulos, E.I.; Eleftherohorinos, I.G.; Vokou, D. In vitro evaluation of essential oils from Mediterranean aromatic plants of the Lamiaceae for weed control in tomato and cotton crops. *Allelopath. J.* **2008**, *22*, 69–78.
261. Uremis, I.; Arslan, M.; Sangun, M.K. Herbicidal activity of essential oils on the germination of some problem weeds. *Asian J. Chem.* **2009**, *21*, 3199–3210.

262. Cruz-Silva, C.T.A.; Nóbrega, L.H.P.; Dellagostin, S.M.; Silva, C.F.G. *Salvia officinalis* L. coverage on plants development. *Rev. Bras. Plantas Med.* **2016**, *18*, 488–493. [[CrossRef](#)]
263. El-Rokiek, K.G.; El-din, S.A.S.; El-Wakeel, M.A.; Dawood, M.G.; El-Awadi, M. Allelopathic effect of the two medicinal plants *Plectranthus amboinicus* (Lour.) and *Ocimum basilicum* L. on the growth of *Pisum sativum* L. and associated weeds. *Middle East J. Agric. Res.* **2018**, *7*, 1146–1153.
264. Skrzypek, E.; Repka, P.; Stachurska-Swakon, A.; Barabasz-Krasny, B.; Mozdzen, K. Allelopathic effect of aqueous extracts from the leaves of peppermint (*Mentha piperita* L.) on selected physiological processes of common sunflower (*Helianthus annuus* L.). *Not. Bot. Horti Agrobot. Cluj Napoca* **2015**, *43*, 335–342. [[CrossRef](#)]
265. Ulbrich, A.; Kahle, H.; Kramer, P.; Schulz, M. *Mentha* × *piperita* volatiles promote *Brassica oleracea*—A pilot study for sustainable vegetable production. *Allelopath. J.* **2018**, *43*, 93–104. [[CrossRef](#)]
266. Karkanis, A.; Alexiou, A.; Katsaros, C.; Petropoulos, S. Allelopathic activity of spearmint (*Mentha spicata* L.) and peppermint (*Mentha* × *piperita* L.) reduces yield, growth, and photosynthetic rate in a succeeding crop of maize (*Zea mays* L.). *Agronomy* **2019**, *9*, 461. [[CrossRef](#)]
267. Matysiak, K.; Kaczmarek, S.; Kierzek, R. Allelopathic effect of popular medicinal plants on *Fagopyrum esculentum* (Moench), *Papaver somniferum* (L.) and *Brassica napus* var. *oleifera* (L.). *J. Med. Plants Res.* **2014**, *8*, 1051–1059.
268. Kadoglidou, K.; Chatzopoulou, P.; Maloupa, E.; Kalaitzidis, A.; Ghoghoberidze, S.; Katsantonis, D. *Mentha* and *Oregano* soil amendment induces enhancement of tomato tolerance against soilborne diseases, yield and quality. *Agronomy* **2020**, *10*, 406. [[CrossRef](#)]
269. Nasrollahi, P.; Razavi, S.M.; Ghasemian, A.; Zahri, S. Physiological and biochemical responses of lettuce to thymol, as allelochemical. *Russ. J. Plant Physiol.* **2018**, *65*, 598–603. [[CrossRef](#)]
270. Othira, J.O.; Deng, A.L.; Onek, L.A.; Kemey, J.; Omolo, E.O. Potential application of *Hyptis spicigera* for biological control of *Striga hermonthica* infestation. *Afr. J. Agric. Res.* **2008**, *3*, 747–752.
271. Brahmi, F.; Khodir, M.; Mohamed, C.; Pierre, D. Chemical composition and biological activities of *Mentha* species. In *Aromatic and Medicinal Plants—Back to Nature*; El-Shemy, H.A., Ed.; IntechOpen: London, UK, 2017. [[CrossRef](#)]
272. Kalemba, D.; Synowiec, A. Agrobiological interactions of essential oils of two menthol mints: *Mentha piperita* and *Mentha arvensis*. *Molecules* **2020**, *25*, 59. [[CrossRef](#)]
273. Franzios, G.; Mirotsoy, M.; Hatzia Apostolou, E.; Kral, J.; Scouras, Z.G.; Mavragani-Tsipidou, P. Insecticidal and genotoxic activities of mint essential oils. *J. Agric. Food Chem.* **1997**, *45*, 2690–2694. [[CrossRef](#)]
274. Silva, L.F.; Cardoso, M.G.; Batista, L.R.; Gomes, M.S.; Rodrigues, L.M.A.; Rezende, D.A.C.S.; Teixeira, M.L.; Carvalho, M.S.S.; Santiago, J.A.; Nelson, D.L. Chemical characterization, antibacterial and antioxidant activities of essential oils of *Mentha viridis* L. and *Mentha pulegium* L. *Am. J. Plant Sci.* **2015**, *6*, 666–675. [[CrossRef](#)]
275. Maffei, M.; Camusso, W.; Sacco, W. Effect of *Mentha* × *piperita* essential oil and monoterpenes on cucumber root membrane potential. *Phytochemistry* **2001**, *58*, 703–707. [[CrossRef](#)]
276. Dob, T.; Dahmane, D.; Benabdelkader, T.; Chelghoum, C. Studies on the essential oil composition and antimicrobial activity of *Thymus algeriensis* Boiss. et Reut. *Int. J. Aromather.* **2006**, *16*, 95–100. [[CrossRef](#)]
277. Giordani, R.; Hadeif, Y.; Kaloustian, J. Compositions and antifungal activities of essential oils of some Algerian aromatic plants. *Fitoterapia* **2008**, *79*, 199–203. [[CrossRef](#)]
278. Mahmoudi, M.; Morteza-Semnani, K.; Mojra, E. Anti-inflammatory and antinociceptive activity of *Thymus pubescens* extract. *Fitoterapia* **2008**, *79*, 361–365. [[CrossRef](#)]
279. Hazzit, M.; Baaliouamer, A.; Verissimo, A.R.; Faleiro, M.L.; Miguel, M.G. Chemical composition and biological activities of Algerian *Thymus* oils. *Food Chem.* **2009**, *116*, 714–721. [[CrossRef](#)]
280. Tohidi, B.; Rahimmalek, M.; Arzani, A. Essential oil composition, total phenolic, flavonoid contents, and antioxidant activity of *Thymus* species collected from different regions of Iran. *Food Chem.* **2017**, *220*, 153–161. [[CrossRef](#)]
281. Ghasemi, G.; Alirezalu, A.; Ghosta, Y.; Jarrahi, A.; Safavi, S.A.; Abbas-Mohammadi, M.; Barba, F.J.; Munekeata, P.E.S.; Domínguez, R.; Lorenzo, J.M. Composition, antifungal, phytotoxic, and insecticidal activities of *Thymus kotschyanus* essential oil. *Molecules* **2020**, *25*, 1152. [[CrossRef](#)]
282. Szczepanik, M.; Zawitowska, B.; Szumny, A. Insecticidal activities of *Thymus vulgaris* essential oil and its components (thymol and carvacrol) against larvae of lesser mealworm, *Alphitobius diaperinus* Panzer (Coleoptera: Tenebrionidae). *Allelopath. J.* **2012**, *30*, 129–142.
283. Araújo, E.C.C.; Silveira, E.R.; Lima, M.A.S.; Neto, M.A.; de Andrade, I.L.; Lima, M.A.A. Insecticidal activity and chemical composition of volatile oils from *Hyptis martiusii* Benth. *J. Agric. Food Chem.* **2003**, *51*, 3760–3762. [[CrossRef](#)] [[PubMed](#)]
284. Souza, L.K.H.; de Oliveira, C.M.A.; Ferri, P.H.; de Oliveira, J.G., Jr.; de Souza, A.H., Jr.; Fernandes, O.F.L.; Silva, M.R.R. Antimicrobial activity of *Hyptis ovalifolia* towards dermatophytes. *Mem. do Inst. Oswaldo Cruz* **2003**, *98*, 963–965. [[CrossRef](#)] [[PubMed](#)]
285. Raizada, P. Ecological and vegetative characteristics of a potent invader, *Hyptis suaveolens* Poit. from India. *Lyonia* **2006**, *11*, 115–120.
286. Sharma, G.P.; Raizada, P.; Raghubanshi, A.S. *Hyptis suaveolens*: An emerging invader of Vindhyan plateau, India. *Weed Biol. Manag.* **2009**, *9*, 185–191. [[CrossRef](#)]

287. Sharma, A.; Batish, D.R.; Singh, H.P.; Jaryan, V.; Kohli, R.K. The impact of invasive *Hyptis suaveolens* on the floristic composition of the periurban ecosystems of Chandigarh, northwestern India. *Flora* **2017**, *233*, 156–162. [[CrossRef](#)]
288. Chatiyanon, B.; Tanee, T.; Talubmook, C.; Wongwattana, C. Effect of *Hyptis suaveolens* Poit leaf extracts on seed germination and subsequent seedling growth of *Pennisetum setosum* (Swartz.) L. C. Rich and *Mimosa invisa* Mart. *Agric. J.* **2012**, *7*, 17–20.
289. Afreen, T.; Srivastava, P.; Singh, H.; Singh, J.S. Effect of invasion by *Hyptis suaveolens* on plant diversity and selected soil properties of a constructed tropical grassland. *J. Plant Ecol.* **2018**, *11*, 751–760. [[CrossRef](#)]
290. Tripathi, A.K.; Upadhyay, S. Repellent and insecticidal activities of *Hyptis suaveolens* (Lamiaceae) leaf essential oil against four stored-grain coleopteran pests. *Int. J. Trop. Insect Sci.* **2009**, *29*, 219–228. [[CrossRef](#)]
291. Conti, B.; Benelli, G.; Flamini, G.; Cioni, P.L.; Profeti, R.; Ceccarini, L.; Macchia, M.; Canale, A. Larvicidal and repellent activity of *Hyptis suaveolens* (Lamiaceae) essential oil against the mosquito *Aedes albopictus* Skuse (Diptera: Culicidae). *Parasitol. Res.* **2012**, *110*, 2013–2021. [[CrossRef](#)]
292. Adjou, E.S.; Chougourou, D.; Soumanou, M.M. Insecticidal and repellent effects of essential oils from leaves of *Hyptis suaveolens* and *Ocimum canum* against *Tenebroides mauritanicus* (L.) isolated from peanut in post-harvest. *J. Consum. Prot. Food Saf.* **2019**, *14*, 25–30. [[CrossRef](#)]
293. Fragoso-Serrano, M.; González-Chimeo, E.; Pereda-Miranda, R. Novel labdane diterpenes from the insecticidal plant *Hyptis spicigera*. *J. Nat. Prod.* **1999**, *62*, 45–50. [[CrossRef](#)] [[PubMed](#)]
294. Noudjou, F.; Kouninki, H.; Ngamo, L.S.T.; Maponmestsem, P.M.; Ngassoum, M.; Hance, T.; Haubruge, E.; Malaisse, F.; Marlier, M.; Lognay, G.C. Effect of site location and collecting period on the chemical composition of *Hyptis spicigera* Lam. an insecticidal essential oil from north-Cameroon. *J. Essent. Oil Res.* **2007**, *19*, 597–601. [[CrossRef](#)]
295. Mukerjee, S.K. A revision of the Labiatae of the Indian Empire. *Rec. Bot. Surv. Ind.* **1940**, *14*, 1–205.
296. Ryding, O. Phylogeny of the Leucas Group (Lamiaceae). *Syst. Bot.* **1998**, *23*, 235–247. [[CrossRef](#)]
297. Maheswaran, R.; Sathish, S.; Ignacimuthu, S. Larvicidal activity of *Leucas aspera* (Willd.) against the larvae of *Culex quinquefasciatus* Say. and *Aedes aegypti* L. *Int. J. Integr. Biol.* **2008**, *2*, 214–217.
298. Islam, A.K.M.M.; Kato-Noguchi, H. Allelopathic potential of five Labiatae plant species on barnyard grass (*Echinochloa crus-galli*). *Aust. J. Crop Sci.* **2013**, *7*, 1369–1374.
299. Zhang, R.H.; Liu, Z.K.; Yang, D.S.; Zhang, X.J.; Sun, H.D.; Xiao, W.L. Phytochemistry and pharmacology of the genus *Leonurus*: The herb to benefit the mothers and more. *Phytochemistry* **2018**, *147*, 167–183. [[CrossRef](#)]
300. Wu, H.K.; Mao, Y.J.; Sun, S.S.; Xu, Z.Y.; Ma, Y.; Cao, J.X.; Qi, H.; Wu, Z.F.; Li, G.; Yang, W.H. Leojaponic acids A and B, two new homologous terpenoids, isolated from *Leonurus japonicus*. *Chin. J. Nat. Med.* **2016**, *14*, 303–307. [[CrossRef](#)]
301. Bich, T.T.N.; Kato-Noguchi, H. Isolation and identification of a phytotoxic substance from the emergent macrophyte *Centrostachys aquatica*. *Bot. Stud.* **2014**, *55*, 59. [[CrossRef](#)]
302. Kato-Noguchi, H.; Moriyasu, M.; Ohno, O.; Suenaga, K. Growth limiting effects on various terrestrial plant species by an allelopathic substance, loliolide, from water hyacinth. *Aqua. Bot.* **2014**, *117*, 56–61. [[CrossRef](#)]
303. Zaman, F.; Iwasaki, A.; Suenaga, K.; Kato-Noguchi, H. Two allelopathic substances from *Paspalum commersonii* Lam. *Acta Agric. Scand. B Soil Plant Sci.* **2018**, *68*, 342–348. [[CrossRef](#)]
304. Li, L.L.; Zhao, H.H.; Kong, C.H. (–)-Lololide, the most ubiquitous lactone, is involved in barnyardgrass-induced rice allelopathy. *J. Exp. Bot.* **2020**, *71*, 1540–1550. [[CrossRef](#)] [[PubMed](#)]
305. Guerrini, A.; Sacchetti, G.; Guevara, M.P.E.; Paganetto, G.; Grandini, A.; Maresca, I.; Menghini, L.; Di Martino, L.; Marengo, A.; Tacchini, M. Wild Italian *Hyssopus officinalis* subsp. *Aristatus* (Godr.) Nyman: From Morphological and Phytochemical Evidences to Biological Activities. *Plants* **2021**, *10*, 631. [[CrossRef](#)] [[PubMed](#)]
306. Ortiz de Elguea-Culebras, G.; Sánchez-Vioque, R.; Berruga, M.I.; Herraiz-Peñalver, D.; González-Coloma, A.; Andrés, M.F.; Santana-Méridas, O. Biocidal potential and chemical composition of industrial essential oils from *Hyssopus officinalis*, *Lavandula × intermedia* var. *super*, and *Santolina chamaecyparissus*. *Chem. Biodivers.* **2018**, *15*, e1700313. [[CrossRef](#)]
307. Suwitchayanon, P.; Kunasakdakul, K.; Kato-Noguchi, H. Screening the allelopathic activity of 14 medicinal plants from northern Thailand. *Environ. Cont. Biol.* **2017**, *55*, 143–145. [[CrossRef](#)]
308. Pandey, D.; Brown, C. Teak: A global overview. *Unasylva* **2000**, *51*, 3–13.
309. Healey, S.P.; Gara, R.I. The effect of a teak (*Tectona grandis*) plantation on the establishment of native species in an abandoned pasture in Costa Rica. *Ecol. Manag.* **2003**, *176*, 497–507. [[CrossRef](#)]
310. Kenny, A.L.; Pickens, J.B.; Orr, B. Land allocation with the introduction of teak: A case study of smallholder farms in Southern Togo. *J. Sustain. For.* **2014**, *33*, 776–795. [[CrossRef](#)]
311. Newby, J.C.; Cramb, R.A.; Sakanphet, S. Forest transitions and rural livelihoods: Multiple pathways of smallholder teak expansion in Northern Laos. *Land* **2014**, *3*, 482–503. [[CrossRef](#)]
312. Udayana, C.; Andreassen, H.P.; Skarpe, C. Understorey diversity and composition after planting of teak and mahogany in Yogyakarta, Indonesia. *J. Sustain. For.* **2020**, *39*, 494–510. [[CrossRef](#)]
313. Kole, R.K.; Paul, P.; Saha, S.; Das, S. Chemistry and bio-efficacy of teak leaf for weed control in wheat. *Allelopath. J.* **2016**, *39*, 191–204.
314. Lacret, R.; Varela, R.M.; Molinillo, J.M.G.; Nogueiras, C.; Macías, F.A. Anthractone and naphthotectone, two quinones from bioactive extracts of *Tectona grandis*. *J. Chem. Ecol.* **2011**, *37*, 1341–1348. [[CrossRef](#)] [[PubMed](#)]

315. Macías, F.A.; Lacret, R.; Varela, R.M.; Nogueiras, C.; Molinillo, J.M.G. Bioactive apocarotenoids from *Tectona grandis*. *Phytochemistry* **2008**, *69*, 2708–2715. [CrossRef] [PubMed]
316. Güllüce, M.; Sökmen, M.; Daferera, D.; Açar, G.; Ozkan, H.; Kartal, N.; Polissiou, M.; Sökmen, A.; Sahin, F. In vitro antibacterial, antifungal, and antioxidant activities of the essential oil and methanol extracts of herbal parts and callus cultures of *Satureja hortensis* L. *J. Agric. Food Chem.* **2003**, *51*, 3958–3965. [CrossRef]
317. Eminagaoglu, O.; Tepe, B.; Yumrutas, O.; Akpulat, H.A.; Daferera, D.; Polissiou, M.; Sokmen, A. The in vitro antioxidative properties of the essential oils and methanol extracts of *Satureja spicigera* (K. Koch.) Boiss. and *Satureja cuneifolia* ten. *Food Chem.* **2007**, *100*, 339–343. [CrossRef]
318. Askun, T.; Tumen, G.; Satil, F.; Karaarslan, D. Active constituents of some *Satureja* L. species and their biological activities. *Afr. J. Microbiol. Res.* **2012**, *6*, 4623–4633. [CrossRef]
319. The Plant List. Version 1.1. Published on the Internet. Available online: <http://www.theplantlist.org/tpl1.1/search?q=conradina> (accessed on 9 October 2021).
320. Fischer, N.H.; Williamson, G.B.; Tanrisever, N.; De la Peña, A.; Weidenhamer, J.D.; Jordan, E.D.; Richardson, D.R. Allelopathic actions in the Florida scrub community. *Biol. Plant.* **1989**, *31*, 471–478. [CrossRef]
321. Fischer, N.H.; Williamson, G.B.; Weidenhamer, J.D.; Richardson, D.R. In search of allelopathy in the Florida scrub: The role of terpenoids. *J. Chem. Ecol.* **1994**, *20*, 1355–1380. [CrossRef]
322. Williamson, G.B.; Fischer, N.H.; Richardson, D.R.; De la Peña, A. Chemical inhibition of fire-prone grasses by fire-sensitive shrub, *Conradina canescens*. *J. Chem. Ecol.* **1989**, *15*, 1567–1577. [CrossRef]
323. Dosoky, N.S. *Isolation and Identification of Bioactive Compounds from Conradina canescens Gray*; University of Alabama in Huntsville: Huntsville, AL, USA, 2015.
324. De la Peña, A.C. *Terpenoids from Conradina canescens (Labiatae) with Possible Allelopathic Activity*; Louisiana State University: Baton Rouge, LA, USA, 1985.
325. Weidenhamer, J.D.; Macias, F.A.; Fischer, N.H.; Williamson, G.B. Just how insoluble are monoterpenes? *J. Chem. Ecol.* **1993**, *19*, 1799–1807. [CrossRef]
326. Rout, O.P.; Acharya, R.; Mishra, S.K.; Sahoo, R. Pathorchur (*Coleus aromaticus*): A review of the medicinal evidence for its phytochemistry and pharmacology properties. *Int. J. Appl. Biol. Pharm. Technol.* **2012**, *3*, 348–355.
327. Soni, H.; Singhai, A.K. Recent updates on the genus *Coleus*: A review. *Asian J. Pharm. Clin. Res.* **2012**, *5*, 12–17.
328. Tanrisever, N.; Fischer, N.H.; Williamson, G.B. Menthofurans from *Calamintha ashei*: Effects on *Schizachyrium scoparium* and *Lactuca sativa*. *Phytochemistry* **1988**, *27*, 2523–2526. [CrossRef]
329. Weidenhamer, J.D.; Menelaou, M.; Macias, F.A.; Fischer, N.H.; Richardson, D.R.; Williamson, G.B. Allelopathic potential of menthofuran monoterpenes from *Calamintha ashei*. *J. Chem. Ecol.* **1994**, *20*, 3345–3359. [CrossRef]
330. Harwood, S.H.; Moldenke, A.F.; Berry, R.E. Toxicity of pepper mint monoterpenes to the variegated cutworm (Lepidoptera: Noctuidae). *J. Econ. Entom.* **1990**, *83*, 1761–1767. [CrossRef]
331. Gunderson, C.A.; Samuelian, J.H.; Evans, C.K.; Brattsten, L.B. Effects of the mint monoterpene epulegoneon *Spodoptera eridania* (Lepidoptera: Noctuidae). *Environ. Entom.* **1985**, *14*, 859–861. [CrossRef]
332. Duke, S.O. Herbicides from natural compounds. *Weed Technol.* **1987**, *1*, 122–128. [CrossRef]
333. Mason, J.R. Evaluation of d-pulegone as a repellent. *J. Wildl. Manag.* **1990**, *54*, 130–135. [CrossRef]
334. De Mastro, G.; El Mahdi, J.; Ruta, C. Bioherbicidal potential of the essential oils from mediterranean *Lamiaceae* for weed control in organic farming. *Plants* **2021**, *10*, 818. [CrossRef]
335. Song, B.; Seiber, J.N.; Duke, S.O.; Li, Q.X. Green plant protection innovation: Challenges and perspectives. *Engineering* **2020**, *6*, 483–484. [CrossRef]
336. Clay, S.A. Near-term challenges for global agriculture: Herbicide-resistant weeds. *Agron. J.* **2021**, *113*, 4463–4472. [CrossRef]
337. Echeng, F.; Echeng, Z. Research progress on the use of plant allelopathy in agriculture and the physiological and ecological mechanisms of allelopathy. *Front. Plant Sci.* **2015**, *6*, 1020.
338. Dudareva, N.; Andersson, S.; Orlova, I.; Gatto, N.; Reichelt, M.; Rhodes, D.; Boland, W.; Gershenzon, J. The nonmevalonate pathway supports both monoterpene and sesquiterpene formation in *Snapdragon* flowers. *Proc. Natl. Acad. Sci. USA* **2005**, *102*, 933–938. [CrossRef] [PubMed]
339. Kasahara, H.; Hanada, A.; Kuzuyama, T.; Takagi, M.; Kamiya, Y.; Yamaguchi, S. Contribution of the mevalonate and methylerythritol phosphate pathways to the biosynthesis of gibberellins in *Arabidopsis*. *J. Biol. Chem.* **2002**, *277*, 45188–45194. [CrossRef]
340. Kumar, A.; Memo, M.; Mastinu, A. Plant behaviour: An evolutionary response to the environment? *Plant Biol.* **2020**, *22*, 961–970. [CrossRef]
341. Vaughn, F.S.; Spencer, F.G. Volatile monoterpenes as potential parent structures for new herbicides. *Weed Sci.* **1993**, *41*, 114–119. [CrossRef]
342. Elakovich, S.D. Terpenoids as models for new agrochemicals. In *Biologically Active Natural Products*; Cutler, H.G., Ed.; ACS Symposium Series; American Chemical Society: Hattiesburg, MS, USA, 1988; Volume 380, pp. 250–261.
343. Rasmann, S.; Köllner, T.G.; Degenhardt, J.; Hiltbold, I.; Toepfer, S.; Kuhlmann, U.; Gershenzon, J.; Turlings, T.C. Recruitment of entomopathogenic nematodes by insect-damaged maize roots. *Nature* **2005**, *434*, 732–737. [CrossRef]
344. Dudareva, N.; Negre, F.; Nagegowda, D.A.; Orlova, I. Plant volatiles: Recent advances and future perspectives. *Crit. Rev. Plant Sci.* **2006**, *25*, 417–440. [CrossRef]

345. Abd-ElGawad, A.; Elshamy, A.; El Gendy, A.E.N.; Gaara, A.; Assaeed, A. Volatiles profiling, allelopathic activity, and antioxidant potentiality of *Xanthium strumarium* leaves essential oil from Egypt: Evidence from chemometrics analysis. *Molecules* **2019**, *24*, 584. [[CrossRef](#)]
346. Tsai, R.; Yu, Q. Nematicidal activity of monoterpenoid compounds against economically important nematodes in agriculture. *J. Essent. Oil Res.* **2000**, *12*, 350–354. [[CrossRef](#)]
347. Park, I.K.; Kim, J.; Lee, S.G.; Shin, S.C. Nematicidal activity of plant essential oils and components from Ajowan (*Trachyspermum ammi*), Allspice (*Pimenta dioica*) and Litsea (*Litsea cubeba*) essential oils against Pine wood nematode (*Bursaphelenchus xylophilus*). *J. Nematol.* **2006**, *39*, 275–279.
348. Shasany, A.K.; Gupta, S.; Gupta, M.K.; Naqvi, A.A.; Bahl, J.R.; Khanuja, S.P.S. Assessment of menthol mint collection for genetic variability and monoterpene biosynthetic potential. *Flavour Frag. J.* **2010**, *25*, 41–47. [[CrossRef](#)]
349. Fejer, J.; Grulova, D.; Salamon, I. Clonal breeding of peppermint (*Mentha* × *Piperita*) with high content of menthol. *Acta Hortic.* **2014**, *1023*, 173–178. [[CrossRef](#)]
350. Srivastava, A.; Gupta, S.; Singh, S.; Verma, R.S.; Srivastava, R.K.; Gupta, A.K.; Lal, R.K. Genetic variability and elite line selection for high essential oil and nepetalactone content in catmint (*Nepeta cataria* L.). *Am. J. Plant Sci.* **2021**, *12*, 1135–1154. [[CrossRef](#)]
351. Reichert, W.J. The Phytochemical Investigation, Breeding and Arthropod Repellent Efficacy of *Nepeta cataria*. Ph.D. Thesis, Rutgers, The State University of New Jersey, New Brunswick, NJ, USA, 2019. [[CrossRef](#)]
352. Gomes, E.N.; Allen, K.; Jaworski, K.; Zorde, M.; Lockhart, A.; Besancon, T.; Brown, T.; Reichert, W.; Wu, Q.; Simon, J.E. Catnip (*Nepeta cataria* L.): Recent Advances in Botany, Horticulture and Production. *Med. Aroma. Plants N. Am.* **2020**, *6*, 247–284. [[CrossRef](#)]
353. Jia, K.H.; Liu, H.; Zhang, R.G.; Xu, J.; Zhou, S.S.; Jiao, S.Q.; Yan, X.M.; Tian, X.C.; Shi, T.L.; Luo, H.; et al. Chromosome-scale assembly and evolution of the tetraploid *Salvia splendens* (Lamiaceae) Genome. *Hortic. Res.* **2021**, *8*, 177. [[CrossRef](#)]
354. Song, Z.; Lin, C.; Xing, P.; Fen, Y.; Jin, H.; Zhou, C.; Gu, Y.Q.; Wang, J.; Li, X. A high-quality reference genome sequence of *Salvia miltiorrhiza* provides insights into tanshinone synthesis in its red rhizomes. *Plant Genome* **2020**, *13*, e20041. [[CrossRef](#)]
355. Lichman, B.R.; Godden, G.T.; Hamilton, J.P.; Palmer, L.; Kamileen, M.O.; Zhao, D.; Vaillancourt, B.; Wood, J.C.; Sun, M.; Kinser, T.J.; et al. The evolutionary origins of the cat attractant nepetalactone in catnip. *Sci. Adv.* **2020**, *6*, eaba0721. [[CrossRef](#)]
356. Li, J.; Wang, Y.; Dong, Y.; Zhang, W.; Wang, D.; Bai, H.; Li, K.; Li, H.; Shi, L. The Chromosome-based Lavender genome provides new insights into *Lamiaceae* evolution and terpenoid biosynthesis. *Hortic. Res.* **2021**, *8*, 53. [[CrossRef](#)]
357. Bornowski, N.; Hamilton, J.P.; Liao, P.; Wood, J.C.; Dudareva, N.; Buell, C.R. Genome sequencing of four culinary herbs reveals terpenoid genes underlying chemodiversity in the *Nepetoideae*. *DNA Res.* **2020**, *27*, dsaa016. [[CrossRef](#)]
358. Vining, K.J.; Johnson, S.R.; Ahkami, A.; Lange, I.; Parrish, A.N.; Trapp, S.C.; Croteau, R.B.; Straub, S.C.K.; Pandelova, I.; Lange, B.M. Draft genome sequence of *Mentha longifolia* and development of resources for mint cultivar improvement. *Mol. Plant* **2017**, *10*, 323–339. [[CrossRef](#)] [[PubMed](#)]
359. Leebens-Mack, J.H.; Barker, M.S.; Carpenter, E.J.; Deyholos, M.K.; Gitzendanner, M.A.; Graham, S.W.; Grosse, I.; Li, Z.; Melkonian, M.; Mirarab, S.; et al. One thousand plant transcriptomes and the phylogenomics of green plants. *Nature* **2019**, *574*, 679–685. [[CrossRef](#)]
360. Zebec, Z.; Wilkes, J.; Jervis, A.J.; Scrutton, N.S.; Takano, E.; Breitling, R. Towards synthesis of monoterpenes and derivatives using synthetic biology. *Curr. Opin. Chem. Biol.* **2016**, *34*, 37–43. [[CrossRef](#)] [[PubMed](#)]
361. Zhang, C.; Hong, K. Production of terpenoids by synthetic biology approaches. *Front. Bioeng. Biotechnol.* **2020**, *8*, 347. [[CrossRef](#)] [[PubMed](#)]
362. Mani, V.; Park, S.; Kim, J.A.; Lee, S.I.; Lee, K. Metabolic perturbation and synthetic biology strategies for plant terpenoid production—An updated overview. *Plants* **2021**, *10*, 2179. [[CrossRef](#)]
363. Korman, T.P.; Opgenorth, P.H.; Bowie, J.U. A synthetic biochemistry platform for cell free production of monoterpenes from glucose. *Nat. Commun.* **2017**, *8*, 15526. [[CrossRef](#)]
364. Rolf, J.; Julsing, M.K.; Rosenthal, K.; Lütz, S. A gram-scale Limonene production process with engineered *Escherichia coli*. *Molecules* **2020**, *25*, 1881. [[CrossRef](#)]