PRELIMINARY STUDIES ON THE ALLELOPATHIC EFFECT OF SOME ENDEMIC SPECIES OF AROMATIC PLANTS AND THEIR POSSIBLE USE AS BIO-HERBICIDES

STUDII PRELIMINARE PRIVIND EFECTUL ALELOPATIC AL UNOR SPECII ENDEMICE DE PLANTE AROMATICE ȘI POSIBILA UTILIZARE A ACESTORA CA BIO-ERBICIDE

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Abstract. *Allelopathy as a process defines the process of inhibition or influence of some plants on other associated plants, by means of biochemical compounds or by the production of chemical substances that eliminated in nature by various means inhibit the germination of weed seeds. Studies in the scientific literature indicate that the main plants with allelopathic effect are aromatic and medicinal species containing essential acids or essential oils such as basil, rosemary, fennel, mint, lavender, thyme, or mustard. The potential for using these plants to produce natural herbicides can be significant, and the percentage reduction in the amount and germination rate of weed seeds in crops is high. Further study of this phenomenon is necessary for the development of biologically active substances for the treatment of weed infestation of crops. Allelopathy and its beneficial effects help to control weeds without harming the health of people, wildlife and the environment. Our preliminary studies include a review of research to date and a proposal for the use of allelopathic plants in urban and peri-urban gardens.*

Key words: domestic garden, medicinal and vegetable plants, allelopathy, bio-herbicide

Rezumat. *Alelopatia ca proces definește procedeul de inhibare sau influența unor plante asupra altor plante asociate, prin intermediul unor compuși biochimici sau prin producerea unor substanțe chimice care eliminate în natură prin diferite moduri inhibă germinația semințelor de buruieni. Studiile din literatura științifica menționează ca principalele plante cu efect alelopatic sunt reprezentate de speciile aromatice și medicinale care conțin acizi sau uleiuri eterice cum ar fi: busuiocul, rozmarinul, feniculul, menta, lavanda, cimbru, sau mușcatele. Potențialul de utilizare a acestor plante cu scopul de a produce erbicide naturale, poate fi semnificativ, iar procentul de reducere a cantității și procentul de germinație a semințelor de buruieni din culturi este ridicat. Efectuarea unui studiu mai amănunțit al acestui fenomen este necesar, pentru dezvoltarea de substanțe biologic active pentru tratarea infestării culturilor cu buruieni. Alelopatia și efectele benefice ale acesteia*

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contribuie la combaterea buruienilor fără a afecta sănătatea populație, a faunei și mediul înconjurător. Studiile preliminarii efectuate de noi cuprind o analiză a cercetărilor efectuate până în prezent și o propunere de folosire a plantelor cu efecte alelopatice în grădinile urbane și peri-urbane.

Cuvinte cheie: grădini private, plante medicinale și legumicole, alelopatie, bio-erbicide

INTRODUCTION

All elements and organisms in nature are connected by food chains which are represented by the subsistence links between humans, plants and animals. Since ancient times man has sought to experience and discover these connections and the mechanisms that underlie them. Thus, just as there is a hierarchy among humans to distinguish themselves, and the strongest are on the surface, so also plants struggle for hierarchy. This is influenced by symbiotic ties, competence and environmental factors that have certain negative or positive effects on them [Hangan *et. al.*, 2020].

Due to the different cultivation technologies of different vegetable species, their different association is allowed for a more intensive exploitation of the vegetable potential by practicing a rotation on cultivated land, whether it is a household garden or a farm specializing in vegetables [Istrate *et. al.*, 2023].

Allelopathy is a biological phenomenon, through which biochemical substances are produced, which occurs between plants through the inhibitory influence or mutual interaction of plants with those near them by means of allelochemical substances with a negative or positive effect (aromatic oils). Plants that have the ability to influence the growth and development of other plants by releasing chemical compounds into the growing medium are called allelopathic plants [Stoleru *et. al.*, 2016].

Elroy Leon Rice, in his monograph on allelopathy, describes a more complex definition, including all direct and indirect effects of plants on each other and on other plants. It also mentions researchers who closely observed the phenomenon of allelopathy and ruled out the idea of competition between plants, the allelopathic effect being a cause of the appearance of certain changes in the process of plant development. In disagreement with this, many biologists believe that allelopathy is part of the competition between plants or in some works its effect is not admitted, some studies even eliminate allelopathy as a possible cause of the observed results, [Rice, 2012].

The presence of the allelopathic effect in the soil depends on the addition of certain chemical compounds in the environment or an allelopathic agent, thus allelopathy is separated from competition, not being part of them, because it can be induced, less often it can occur involuntarily between plants [Calara *et. al.*, 2021].

Most of the experiments and studies carried out so far are based on adding plant extracts to the soil to observe their effect on the evolution and development of plants, but allelopathy can also be present by planting different plants together and living together. whether or not they have a beneficial effect on their cultivation [Stoleru *et. al*., 2015].

After documenting and carrying out some reviews on the research carried out, we have extracted some conclusive studies with positive results in the field of allelopathy and its use in agriculture and horticulture.

Allelopathy processes can also be influenced by environmental conditions including UV radiation, temperature, water and nutrient availability, as well as competitive stress between plants. This we can say that the environment can affect the production of allelochemicals in three ways: the production of the compounds, their bioavailability and their effect on the target species [Cheng F. and Cheng Z., 2015].

Environmental stress is a very good precursor to the formation and stimulation of the production of allelochemicals, hormones and the triggering of plant gene expression. Similarly, the stress produced by the interaction between plants is very important in the production of allelochemicals. For example, rice seedlings grown together with *Echinochloa crus-galli*, a grass species, showed stimulation of momilactone B production than that of rice seedlings grown alone. [Cheng F. and Cheng Z., 2015]

The presence of allelochemicals in soil also depends on transfer (absorption and leaching) and degradation (abiotic and biotic) processes. The production of allelochemicals is a complex problem that is affected by the environment and the donor and target plant species, stress and environmental factors involved in the process.

This paper will include a review of allelopathy and allelopathic effect research done so far along with the experimental design of the research.

MATERIAL AND METHOD

The study and work material is represented by a rich specialized literature comprising over 6.000 works on allelopathy and 88 works on urban and peri-urban gardens, works published so far by different authors. Also, the most detailed studies were chosen that best included the necessary details on allelopathic plants and the allelopathic effect, which helps to inhibit the growth and germination of weeds.

Following the results gathered from the research, we chose to use the following aromatic and seasoning plants: basil, thyme, oregano, rosemary, sage and pelargonium sp. along with several other vegetable species.

The working method is represented by deepening and understanding the results obtained so far by researchers in the field and choosing the plants with the greatest potential and using them in one's own experience to understand exactly the mechanisms of allelopathy and the potential for use for beneficial purposes.

DISCUSSIONS ON THE INFLUENCE OF PLANTS WITH AN ALLELOPATHIC EFFECT

Following further studies on allelopathy and the effect of allelopathic plants, we found that extracts obtained from aromatic and medicinal herbs as well as some legume species can have positive allelopathic effects against weeds in crops, inhibiting seed germination and even plant growth.

Basil extracts inhibited germination of broadleaf weeds by up to 80% in laboratory experiments and reduced plant biomass by up to 97% in field experiments.

If we talk about herbs, their effect has been tested on several weeds in crops, with lavender, mint, oregano, rosemary and thyme being the most important, giving the best results.

Also, the results of the effects of the treatments for each concentration on each individual plant were analyzed separately, the inhibitory effects of the essential oils had an effect on the germination after 14 days of its production, the germination in the control group being 88%.

However, the essential oils of *Coriandrum sativum*, *Foeniculum vulgare*, *Lavandula Stoechas*, *Pimpinella anisum*, *Rosmarinus oficinalis* and *Salvia officinalis* had a lower inhibition coefficient, especially at low concentrations of 3.6 ml, except for *Raphanus* seeds, which did not show outstanding results, the other seeds showed significant results. Although they did not show a statistically significant result, increasing the concentration to 10-20 ml decreased the germination percentage in the case of *Raphanus* seeds.

Table 1.

Germination rate of weed seeds

Germination rate of weed seeds (%)							
Name of plants	**Hollyhock (*Alcea pallida*)**	**Amaranth (*Amaranthus retroflexus*)**	**Yellow starthisle (*Centaurea solstitialis*)**	**Wild mustard (*Sinapis arvensis*)**	**Field thistle (*Sonchus oleraceus*)**	**Wild radish (*Raphanus raphanistrum*)**	**Patience dock (*Rumex nepalensis*)**
Caraway (*Carum carvi*)	46.7	7.4	7.6	0.5	0.0	0.1	13.6
Coriander (*Coriandrum sativum*)	64.7	37.9	15.8	9.4	10.5	13.2	27.4
Fennel (*Foeniculum vulgare*)	86.7	36.7	16.3	23.0	97.3	5.6	84.2

Control (water)	*p-value*	X^2	Thyma (*Thymbra spicata*)	Sage (*Salvia officinalis*)	Rosemary (*Rosmar*	Anise (*Pimpinella anisum*)	Oregano (*Origanum onites*)	Mint (*Mentha spicata*)	Lavander (*Lavandula stoechas*)
100	**	23.9	74.5	83.4	73.3	84.7	71.7	46.7	58.3
100	***	31.0	1.1	63.7	59.5	53.7	16.5	2..9	36.6
96	**	25.9	41.5	44.4	5.4	61.3	15.4	10.6	12.7
100	***	30.5	0.3	17.0	3.0	66.2	1.1	1.0	1.0
100	***	32.4	1.3	95.1	87.1	97.8	3.2	5.6	30.4
88	***	29.8	0.6	22.7	2.8	10.9	0.2	0.1	1.3
100	***	33.0	35.8	80.6	40.1	92.0	20.2	6.7	56.1

****p<0.001*, **<0.01*

A study of the allelopathic potential of pelargonic acid in *Pelargonium* plants has been studied in a laboratory experiment and its results may be promising for its use as a bio-herbicide against weeds in large crops as well as in small vegetable crops or private gardens.

The study aimed to compare the effectiveness of four solutions of pelargonic acid, three essential oils (*lemon, pine and manuka*) and two mixtures of the two against species of *Lolium rigidum, Avena sterilis and Gallium aparine*.

Table 2.

Results obtained in Lolium rigidum plants

Treatment	Dry weight (%)			Height of plants (%)		
	Day 1	Day 3	Day 7	Day 1	Day 3	Day 7
PA1	46	42	41	44	43	40
PA2	34	29	30	38	27	28
PA3	59	52	53	63	54	51
PA4	41	37	37	42	33	35
EO1	41	27	10	45	28	8
EO2	42	39	40	40	36	38
EO3	38	34	33	37	35	36
MI	37	22	6	36	24	7
M2	36	29	23	40	26	21
LSD (0.05)	8	10	11	7	8	11
***p* value**	**	**	***	***	***	**

*(**Legend:** PA1 – Pelargonic acid 18.67%; PA2 – Pelargonic acid 50%; PA3 – Pelargonic acid 3.102% + maleic hydrazide 0.459%; PA4 – Pelargonic acid 18.67% + maleic hydrazide 3%; EO1 – Manuka oil 5%, EO2 – Lemongrass 5%; EO3 – Pine oil 5%; MI – Pelargonic acid + manuka oil; M2 – pelargonic acid + lemongrass oil)*

The mixtures of pelargonic acid and essential oils significantly reduced the germination of *Lolium rigidum* plants starting from day 3. The values being between 29-18%. PA2 treatment achieved the best results in *Lolium rigidum* plants compared to the control group. The values being between 34-29%.

Very good results were also obtained with EO1 treatment on the third and seventh day of treatment compared to the control group. The values being between 41-10%.

Table 3.

Results obtained in Avena sterilis plants

Treatment	Dry weight (%)			Height of plants (%)		
	Day 1	Day 3	Day 7	Day 1	Day 3	Day 7
PA1	36	33	33	38	36	35
PA2	27	24	23	29	27	24
PA3	48	44	41	53	46	42
PA4	33	30	31	36	33	32
EO1	42	28	7	44	31	12
EO2	36	31	32	37	34	34
EO3	39	35	32	42	37	35
MI	28	18	4	30	20	8
M2	43	25	17	36	25	19
LSD (0.05)	9	8	11	9	7	9
***p* value**	*	**	***	*	**	***

(Legend: *PA1 – Pelargonic acid 18.67%; PA2 – Pelargonic acid 50%; PA3 – Pelargonic acid 3.102% + maleic hydrazide 0.459%; PA4 – Pelargonic acid 18.67% + maleic hydrazide 3%; EO1 – Manuka oil 5%, EO2 – Lemongrass 5%; EO3 – Pine oil 5%; MI – Pelargonic acid + manuka oil; M2 – pelargonic acid + lemongrass oil)*

In the case of sterile oat plants, germination was most inhibited with the PA2 treatment. The germination percentage of plants with values between 29%-23%. Also the treatment EO1 and M1 had a very strong impact on day 7. the germination values being between 7-4% and a plant height between the values of 12-8%. The M2 and PA4 treatments also showed observable effects.

Table 4.

Results obtained in Gallium aparine plants

Treatment	Dry weight (%)			Height of plants (%)		
	Day 1	Day 3	Day 7	Day 1	Day 3	Day 7
PA1	12	5	4	14	6	6
PA2	5	2	0	8	4	0
PA3	17	10	8	20	12	11
PA4	10	5	3	13	6	5
EO1	33	23	8	36	27	11
EO2	30	27	25	33	29	27
EO3	19	16	14	21	19	18
MI	22	12	0	25	13	0
M2	24	15	6	26	16	8
LSD (0.05)	8	6	9	8	7	9
p val**ue**	***	***	**	***	***	**

(Legend:*PA1 – Pelargonic acid 18.67%; PA2 – Pelargonic acid 50%; PA3 – Pelargonic acid 3.102% + maleic hydrazide 0.459%; PA4 – Pelargonic acid 18.67% + maleic hydrazide 3%; EO1 – Manuka oil 5%, EO2 – Lemongrass 5%; EO3 – Pine oil 5%; MI – Pelargonic acid + manuka oil; M2 – pelargonic acid + lemongrass oil)*

The allelopathic potential present in *Ipomoea batatas* plants was tested by performing a laboratory bioassay with aqueous extracts from 17 sweet potato cultivars. The cultivars: *SP0, SP1, SP2, SP3, SP4, SP5, SP6, SP7, SP9, SP10, SP11, SP13, SP14, SP15, SP16, SP18 and SP19.*

The highest inhibition rates were calculated for the leaf extracts which significantly increased the values with increasing concentration.

The highest synthetic inhibition and allelopathic effect was recorded for cultivars *SP19, SP6, SP11* and *SP7* on sterile *Latuca sativa* plants.

Another study is defined by establishing the allelopathic relationship between parsley, fennel, onions, carrots and peppers, a study conducted in the laboratory. Extracts obtained from parsley, dill, carrot and onion significantly reduced the activity of pepper plants by stunting growth and root development. Fennel and carrot extract unexpectedly showed positive effects on the growth and development of seedlings, leading to their improvement.

A laboratory experiment with aqueous extracts of *Lantana camara* leaves showed negative results for pepper and carrot plants. The extracts inhibited *Daucus* *carota* germination by 70%, and for *Capsicum annuum*, root growth was reduced by 49% and vegetative growth by 60%. *Lantana camara* is an invasive weed that impacts seed germination and seedling growth, increasing crop plant mortality.

A study on the allelopathic potential of *Helianthus sp.*, *Sorghum sp.*, and *Oryza sp.* on *Parthenium hysterophorus* plants showed favorable results. Sorghum extracts, especially from shoots, significantly inhibited weed germination, while root extracts were effective at 25% concentration. Sunflower extracts had inhibitory effects below 5%, and rice extracts showed the least inhibition, only at higher concentrations. [Javaid et. al., 2006].

CONCLUSIONS

Allelopathy has a very important impact on vegetable gardens and using it for practical purposes can facilitate their care or supervision.

Conducting this study arose from the need to deepen the information about the allelopathic effect and plants with allelopathic properties in order to use them as a bio-pesticide for the elimination of weeds and protection against diseases and pests.

Essential oils have a multitude of properties, among them is the inhibitory effect on the growth of common weeds in crops.

The use of the allelopathic effect and plants with allelopathic effects can considerably reduce the consumption of pesticides and the need for manual weeding in private gardens.

The use of plants with allelopathic effects can be beneficial for the future of organic crops for food production, by removing pesticides from use and replacing them.

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