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RESEARCH ARTICLE

Allelopathic Activity of Secretions of Plant Mass and Soil From the Form of Monard Double (*Monarda didyma* L.)

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The allopathic properties of secretions from vegetative and generative organs of plants and soil from the spicy-aromatic species of monardial plants during cultivation in soil-climatic conditions of northern and central forest-steppe of Ukraine were analyzed. It is proved that the investigated species of plants has allopathic activity. Based on the analysis of the effect of bivalve monardium extracts on biometric indicators of biotest, it was established that the length of the watercress root is a sensitive indicator and varied over a fairly wide range. Allopathic activity of alcohol-soluble secretions from different organs of the double monarch that grew on the territory of Umani was much higher than the plants in Kyiv. probably they have in their knees certain allelopathic activity, which are more intensively synthesized at the beginning of the development of the monard, during the formation of generative organs allopathic activity is variable, in particular, in the budding phase there is a decrease in its activity, and in the flowering phase - there is flowering.

Keywords: Allelopathic activity; Knees; Biotest; Root growth; Stimulating effect; Inhibitory action; *Monarda didyma* L

Introduction

Monarde didyma L. is a native of Central and South America, cultivated in many European countries, including Eastern Europe, found in the Caucasus and the Crimea as a perennial herb (Lynx, 2006). The generic name of these plants is related to the name of Nicolas Monardes, a Spanish doctor from Sylvia. They are characterized by high aromatic properties. In many European languages, the name monard refers to bergamot or bergamot mint, thanks to its bergamot orange flavor (Grodzinski, 1973). Initially, plants of this genus are grown as a garden ornamental crop, and subsequently to produce valuable essential oil that has multifunctional use (in the perfume and cosmetic industry, in the food industry, in medicine, etc.) (Grodzinski, 1965).

The main components of the oil are thymol and carvacrol. It is used as an antiseptic during the aromatization of soft drinks, as well as in the wine industry (Zharinov, 1994). The leaves of the plant contain carotene, vitamins C, B, as well as mineral, tannic, phenolic compounds. According to the literature, representatives of the genus Monard, in addition to essential oil contains vitamins (C, B1, B2), bitterness, tannins. The plants of the genus Monard are endowed with the aroma of bitter green-yellow citrus fruits of tropical trees from the Rutaceae family. For the monard has an immunomodulatory effect, as well as bactericidal, anthelmintic, antibiotic action (Mashanov, 1991). Therefore, the introduction into the agrophytocenoses of nontraditional plants with herbicidal, antimicrobial, antistocidal and allelopathically active properties that can improve the phytosanitary condition of the soil and maintain its fertility is a new trend in modern agrophytocenology. Representatives of the Lamiaceae family, in particular the genus Monarda L., occupy a significant place in this aspect, with about 20 species of perennial tall plants. Introductions in Ukraine are: *M. didyma* L., M. *citriodora* Cerv., M. *punctata* L., M. *Fistulosa* (Bodrug, 1990).

While allelopathic activity is known to depend not only on the species specificity of the plants, but also on the stages of their development and individual organs, as well as the soil and climatic conditions of their cultivation. The above indicates the relevance of this study. In view of this, the purpose of the study was to investigate the allelopathic activity of different types of secretions of extracts of individual organs and soil from plants in the dynamics of their growth and development, as well as under different soil and climatic conditions.

Materials and Methods

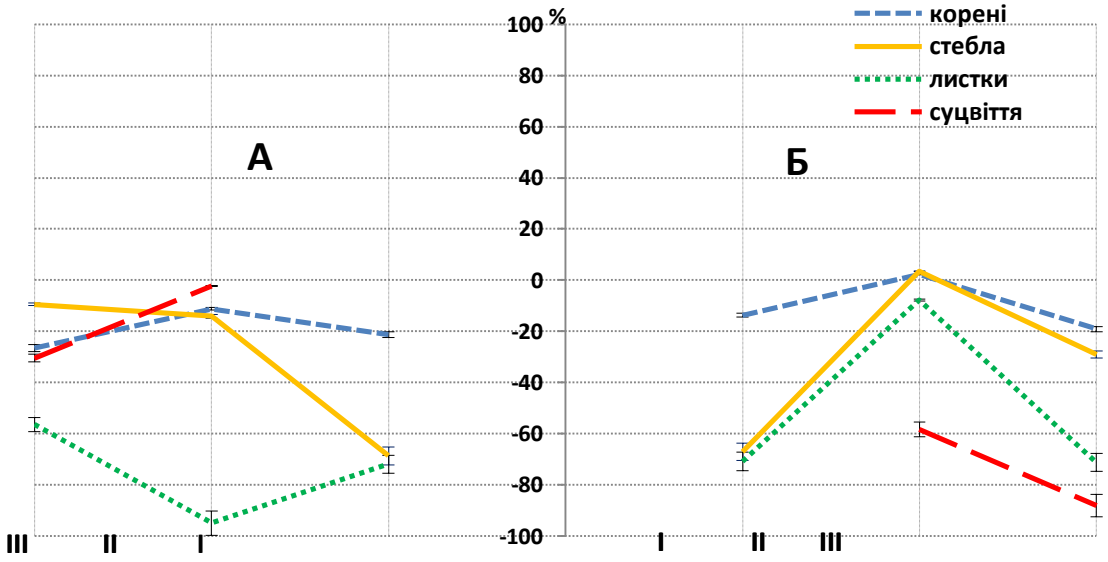
The material of the study was (Figure 1) extracts of fresh organs of plants of the species Monardia double and soil from the rhizosphere and row spacing. The experimental work was performed on the basis of the National Botanical Garden. M.M. Grishko NAS of Ukraine (Kyiv) and the Agrobiological Station of the State Pedagogical University named after I. P.G. Tychyny (Uman, Cherkasy region). In model experiments, allelopathic activity of water-soluble (SRV), alcohol-soluble (SRV) and volatile secretions (LV) plants was determined using biological tests (Grodzinski, 1991) - one-day shoots of cress (*Lepidium sativum* L.) (Grodzinski, 1973). Allelopathic activity was determined by the growth of the roots of biological tests (Grodzinski, 1973). The plant mass was ground and infused in distilled water (BPW) and in 70% ethanol (SRB) for one day at a temperature of 26-27°C. The ratio of biomass to the volume of distilled water or alcohol is 1:10. Petri dishes were made with 5 ml of extract and evenly distributed on 20 bioassays. In the control was made pure extractant. The test vessels were kept in a thermostat for 24 and 48 h. at temperatures of 26-27°C. Then measured the length of the roots, the gain was calculated as a percentage of control.

Figure 1. The appearance of the plants of the species of the monard is twofold.

Moisture, 5 ml of distilled water was used to determine volatile excretion (LV) activity, a filter on which was placed a sample of the desired material (3 g) in a porcelain crucible placed in the center of a Petri dish. Biotests were placed around him, Petri dishes sealed. The conditions of biotest cultivation were the same as in the study of water- and alcohol-soluble compounds.
For the mathematical processing of the results of the study used packages of computer programs Microsoft Office Excel 2003. Statistical data processing was performed according to the method of B.A. Dospekhov (Dospekhov, 1985).

Results and Discussion

It is known that any plant organism is a potential source of physiologically active substances - the knees, because even ordinary, neutral substances such as amino acids, fiber and sugars, which are a component of each plant, under various conditions can be transformed into oligodynamic compounds. However, the potential allelopathic activity in plants is different and depends on the ecological conditions of cultivation and species characteristics (Grodzinski, 1973).
Generalization of allelopathic activity of water-soluble alcohol-soluble and volatile secretions, different organs of the studied plants, was conducted in dynamics at different stages of development. It is established that alcohol-soluble secretions have high physiological activity, respectively, water-soluble occupy an intermediate position and insignificant activity characteristic of volatile substances. The three types of secretions are characterized by a certain phytotoxicity that varies by plant development phase and in some cases has both a stimulating effect and a inhibitory effect or no influence on the test objects.
It is shown that a large number of inhibitory substances localize in the organs that are able to accumulate essential oils (leaves and inflorescences), insignificant - in the roots and stems. The most significant phase in allelopathic activity is the flowering period. The results obtained correspond to the literary data Kalashnikov VP, Levinstein II, Melnichenko AK, Pida SV, Gorobets SA (Pida, 2007, Gorobets, 1992).
It was found that the concentrations in the same concentrations had different effects on the test objects. Among the selected most sensitive to the secretions were the roots of watercress, and winter wheat biotests were dependent on the species characteristics of the experimental plants. In addition, the allelopathic activity of secretions of a particular organ on a particular biotest was both inhibitory and stimulating in nature, depending on the soil and climatic conditions of the plant's cultivation. In Figure 2. results on determination of allelopathic activity of water-soluble secretions from some organs of investigated plants in the dynamics of their development.



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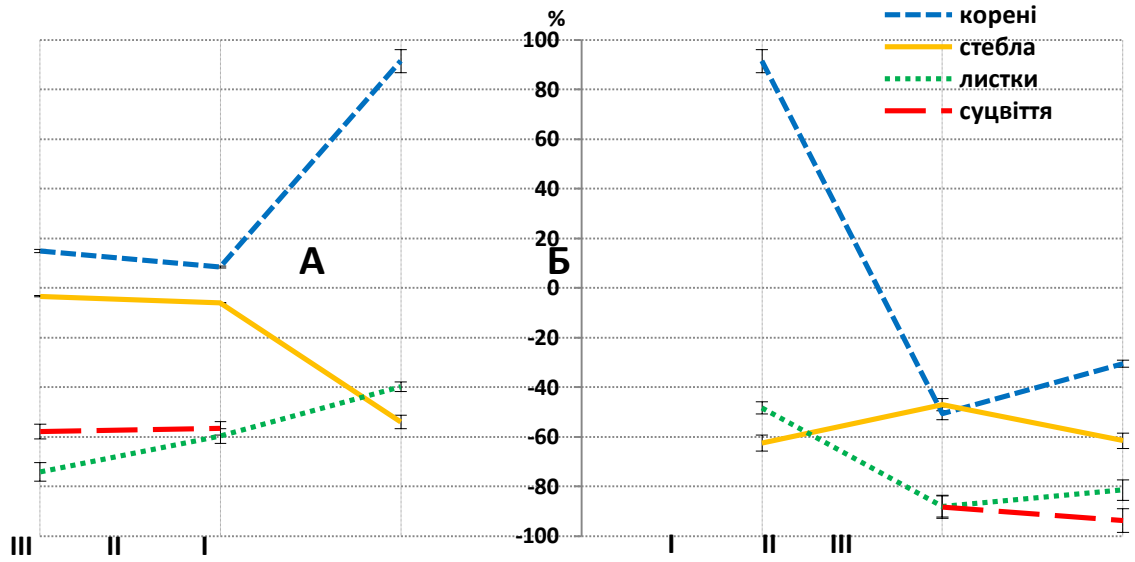

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Figure 2. Dynamics of allelopathic activity of different types of discharge from the organs of the monard (biotest - roots of salad watercress)
Note: a) - Water-soluble extracts; b) - Alcohol-soluble extracts; c) - Volatile selection.
Research base: A - National Botanical Garden them. M. Grishko (Kyiv); B - Uman agro-biological station.
Phases of plant development: I - The Beginning of development; II - Budding; III - Flowering.

It has been established that aqueous extracts from different organs of the monardia during the vegetation are variable in nature from the braking and stimulating direction, with the first-order knees predominating by visual assessment over the others. The results obtained indicate the high sensitivity of watercress roots to the knees-inhibitors, which can be clearly observed for plants cultivated on the territory of Kyiv and Uman. Although the allelopathic activity of water-soluble secretions from different organs differs to some extent, the tendency of its recession or growth remains the same in the conditions of Kyiv and Uman.
In particular, water-soluble secretions from monarchic roots did not affect the development of watercress roots, whereas inflorescences and leaves inhibited their growth (flowering phase). Water extracts from the stems at the beginning of the growth of the monarde, had a inhibitory effect, in the budding phase, there was no influence of secretions, and during the flowering period they were negligible phytotoxicity except for plants grown on the territory of agrobiostation. Some differences in the allelopathic activity of water-soluble secretions from different organs of the monard were observed when used as a biotest of winter wheat. The results show that the knees mainly had a stimulating effect, except the discharge from the inflorescences, which have a inhibitory effect.
Significant differences were found in the study of volatile secretions. Analysis of the dynamics of their accumulation in the organs of the monard under different conditions of cultivation during the growing season shows the changing nature of the activity of the knees, both stimulating and inhibitory action. It should be noted that at the beginning of the regrowth of plants the volatile secretions of all the organs of the monard both in the conditions of Kyiv and Uman stimulated the growth of the roots of watercress.
In the budding phase, the activity of volatile secretions was characterized by high phytotoxic activity, which during the flowering period decreases, becoming neutral in nature. Among the brake-knees in the various organs of the monard, the greatest number is recorded in the inflorescences. Some other results were obtained in experiments with other test objects.
Thus, volatile secretions from different organs of plants in the conditions of Kyiv during the growing season had an exclusively inhibitory effect on the growth of winter wheat roots and coleoptiles. Moreover, if at the beginning of development the activity is quite high, then during the formation of generative organs it decreases significantly. It should be noted that under the conditions of Uman there was no influence of knees from all organs of experimental plants on the development of wheat roots during the first two phases of development.
In the flowering period, on the contrary, there was an increase in volatile secretions for all organs except inflorescences in which the inhibitory action decreased. Significant differences were also revealed during the analysis of the development of coleoptiles of wheat under the influence of volatile secretions from different organs of the monarde, which was grown under the conditions of an agrobiostation, namely: both at the beginning of the growing season and during flowering plants, the knees stimulated the development of coleoptiles, and during budding allelopathic activity was low.
Note worthy are the data obtained in the study of alcohol-soluble secretions by different organs of plants. Yes, monardia alcohol extracts in the dynamics of plant growth and development under different climatic conditions of cultivation had a retarding effect on the selected test objects. Extracts of inflorescences and leaves have been found to contain much more phytotoxic substances than root and stem extracts, a Thus, their activity is manifested mainly in the budding phase. Analysis of the content of physiologically active substances in the monarch phytomass alcohol fractions indicates a gradual increase in the content of inhibitory knees during the period of active plant growth, which may be related to the synthesis of terpene and phenolic compounds. In addition to the inhibitory effect on biotests, the stimulating effect of root and stem extracts was observed, both at the beginning of plant formation and in the budding phase. As a rule, the allelopathic activity of alcohol-soluble secretions from different organs of the monard in the conditions of Uman is much higher than for plants in the territory of Kyiv. Thus, the knees are more intensively synthesized at the beginning of the development of the monard, during the formation of generative organs allelopathic activity is variable, in particular, in the budding phase there is a decrease in its activity, and in the flowering phase - there is an increase in phytotoxicity.
Most exometabolites of plants accumulate in the soil of the rhizosphere and rhizoplan and contribute to the enrichment of its organic compounds and mineral elements, as well as the accumulation of humus. As a result of the receipt of biologically active substances

in the soil during the vegetation of plants, the composition and their content is constantly changing, which leads to a certain allelopathic effect. The results obtained indicate the correlation between the accumulation of phytotoxic substances and the type of soil and climatic conditions (Figure 3).

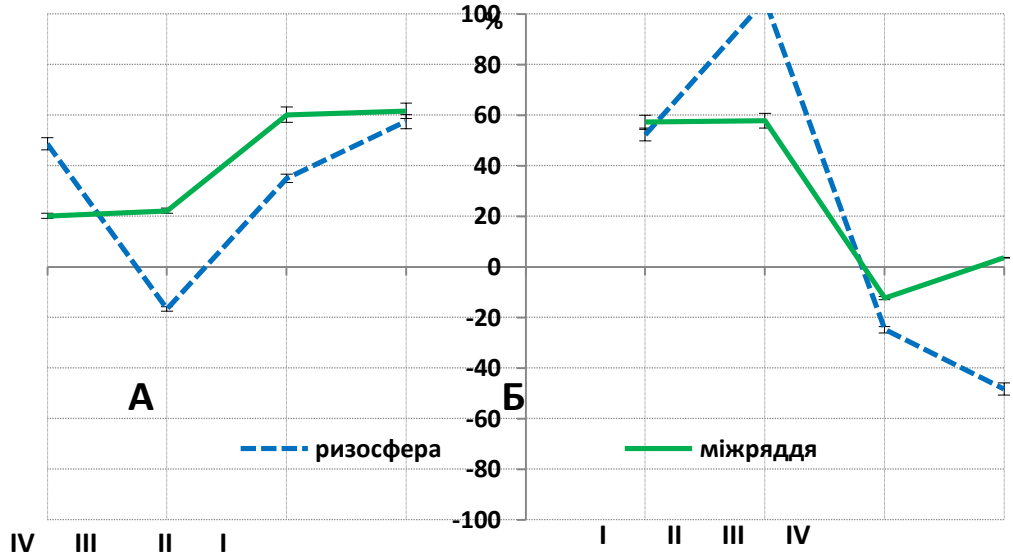

Figure 3. Dynamics of allelopathic soil activity from aromatic plants (biotest - roots of watercress)
Note: Research base: A - National Botanical Garden them. M. Grishko (Kyiv); B - Uman agro-biological station.
Phases of plant development: And - the beginning of development; II - budding; III – flowering; IV - post-harvest period.

It is found that the soil of the rhizosphere and the row of monarchs of the bivalve during the growing season has a variable nature of both stimulating and inhibitory direction. The most specific nature of the action of the compounds from the rhizospheric soil of the monard is shown in the biotest of watercress. In particular, it has been shown that the allelopathic activity of soil in climatic conditions of Uman gradually changes in the process of plant growth and development and acquires phytotoxicity during flowering. Conversely, under conditions of the city of Kyiv, during the flowering period of the monard, a minimal amount of toxic substances accumulates in the soil, which sharply decreases in the post-harvest period. Thus, the results of allelopathic studies have shown that during the flowering period of the monard, the bivalve soil is characterized by phytotoxic properties, which can be explained by the formation of substances of phenolic nature.

Conclusion

Summarizing the results obtained, it can be noted that the analysis of the seasonal dynamics of allelopathic activity of secretions of different organs of experimental plant species showed the following: alcohol-soluble secretions are characterized by the highest physiological activity, respectively, water-soluble secretions occupy an intermediate position, but not volatile substances. It is proved that the maximum amount of inhibitory substances is localized in leaves and inflorescences that can accumulate essential oils, insignificant - in roots and stems. For monard plants, the most indicative phase in the manifestation of allelopathic activity is the flowering period. Selected test objects were pickle roots. In the budding phase, the activity of volatile secretions had a high phytotoxic activity, which further decreased, becoming neutral. Alcohol soluble extracts of monardia from inflorescences and leaves contained significantly more phytotoxic substances than extracts from roots and stems. In addition, allelopathic activity releases from the organs of plants in climatic conditions of Uman are much higher than in Kyiv. It has been found out that the knees are intensively synthesized at the beginning of the growth of the monard, in the budding phase there is a decrease in allelopathic activity, and in the flowering phase, on the contrary, it is increasing.

The soil of the rhizosphere and row spacing in the cultivation of aromatic plants accumulates in its mass allelopathically active substances, which leads to a slight toxicity. As, the content of knees in soil undergoes constant changes, so during the growing season allelopathic activity of soil grows and reaches its maximum level in September-October. During the winter and spring period, the knees are partially washed out by precipitation, partially reduced by microorganisms, or adsorbed by the soil absorption complex, which leads to a decrease in soil toxicity at the beginning of plant regrowth. During the flowering period in the aboveground mass of the studied species there is an accumulation of essential oils and their release into the environment. Therefore, during this period, the highest soil toxicity was recorded.

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