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DEVELOPMENTAL TRAITS IN GRASSLAND AND AGRICULTURAL PLANTS UNDER THE INFLUENCE OF RAGWEED

O. Y. BUZHDYGAN[1], O. V. BAGLEI[2]

Department of Ecology and Biomonitoring,
Institute of Biology, Chemistry and Bioresources,
Chernivtsi Natonal University, Chernivtsi 58012, Ukraine
e-mail:[1]oksana.buzh@gmail.com
[2]o.bagley@chnu.edu.ua

The problem of invasion and naturalization some of adventive species is very important in current moment. First of all, it concerns the species which influence to the human being. The Ambrosia artemisifolia L. is an one of example of these species. This species quickly finds the optimal conditions to grow, it's not only the strong allergen but it also decreases the quality of phytocoenosis. Allelopathic activity of ragweed respectively towards other species remains unclear. That makes it difficult to understand the ragweed phytocenotic compatibility with the both cultural and wild-growing plant species. In current work we make an attempt to assess the allelopathic effect of the quarantine species Ambrosia artemisifolia L. on the growth and development of the widely used in Ukrainian agriculture five perennial grasses, as well as on two species of wild meadow mixed grass plants. Significantly lower seed germination of the following species under the effect of the water-soluble allelopathic substances of ragweed has been demonstrated: Helianthus annuus L., Medicago sativa L., Trifolium pretense L., Prunella vulgaris L., and Plantago major L. At the same time Hordeum vulgare L. has shown significantly higher seed germination under the effect of ragweed. Less sensitivity of the seedling standing stock in comparison to the seedling length has been demonstrated for the study species under the effect of the allelopathic substances of ragweed. Phytocoenotic compatibility of the studied cultural and wild-growing plants with the ragweed allelopathic activity has been shown.

Key words: ragweed, Ambrosia artemisifolia L., allelopathy, quarantine species, cultural plants, wild-growing plants, morphometric parameters.

Introduction. The last decade has seen the rapid increase of the interest to the *Ambrosia artemisifolia* L. by public, science and medicine (Bohren et al 2008, Delebays et al 2002, Protopopova et al 2004) due to the wide spread of this species due to anthropogenic climate change, as well as positive response to the higher temperatures and rising CO2 concentration in the air, increased production of seeds and pollen that has a strong allergenic effect (Basset et al 1975; Bertran et al 1996; Rogers et al 2006; Singer et al, 2005). In addition to, ragweed has allelopathic substances that inhibit the growth and development of many plants (Mar'uschkina, 2009; Mar'uschkina, 2006). This species rapidly colonizes the new plant communities, taking out the water from soil and significant nutrient elements as phosphorus and nitrogen (Bogoslovskaja, 2011). *Ambrosia artemisifolia* L. is strong allergen and ragweed. It can be found everywhere: urban areas, among agricultural fields, vegetable gardens, gardens, along the roads and riversides. In Ukraine, the ragweed was first found in 1914 in the Dnipropetrovsk Region and has been spreading in the eastern Ukraine till the 1972 (Protopopova et al., 2004). Fig. 1 shows expansion of ragweed within the territory of Ukraine (Artemchuk et al 1939; Protopopova et al 2004; Protopopova, 1970; Symonov, 2011).

Despite of the significant funds spent by local authorities on the control programs against ragweed expansion, such programs are ineffective and need a new integrative approach (Podberezko et al 2013), which is to integrate a scientific knowledge of the ecological characteristics of ambrosia species, as well as practical experience in minimization and elimination of the current quarantine species (The Law of Ukraine…,2006).

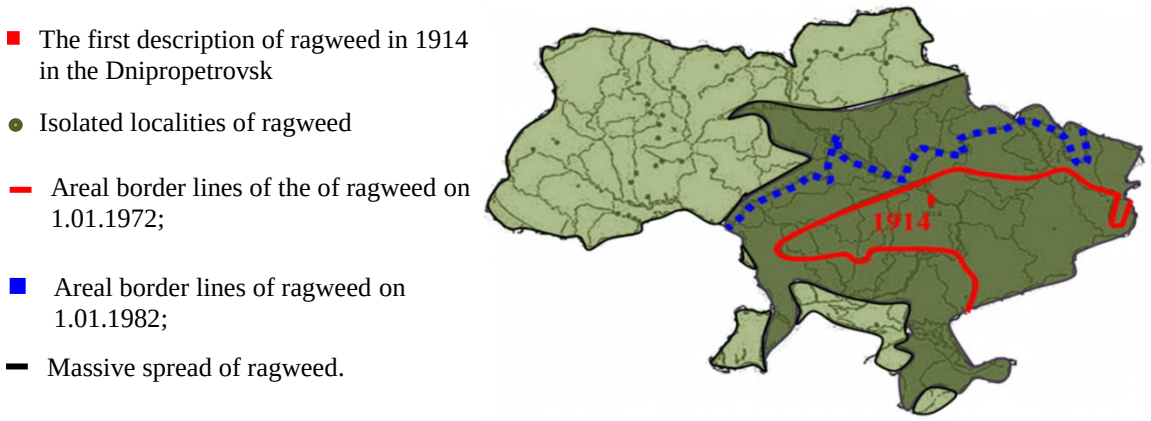

Fig 1. Expansion of ragweed within the territory of Ukraine (Protopopova et al 2004)

Allelopathy is the interaction between plants by isolation of biologically active substances into the external environment. Herewith, the effect can be stimulating as well inhibitory. Allelopathic activity of ragweed respectively towards other species remains unclear. That makes it difficult to understand the ragweed phytocenotic compatibility with the both cultural and wild-growing plant species. It's known, that *Ambrosia artemisifolia* L. develops a strong aboveground mass and root system and strongly suppresses the crops. In meadows and pastures *A. artemisifolia* L. displaces a cereals-legumes grasses and dramatically reduces the quality of forage because it's not eaten by cattle as a result of the bitter content of essential oils (Behrend et al 2010; Bertran et al 1996; Bogoslovskaja, 2011). There are some datas that *A. artemisifolia* synthesizes izohlorogenic and chlorogenic acids, the ester of glucose and caffeic acid, which inhibit the germination of many plant species (Basset, 1975; Beres, 1994).

In current work we assess the allelopathic effect of the quarantine species *Ambrosia artemisifolia* L. on the growth and development of the widely used in Ukrainian agriculture five perennial grasses, as well as on two species of wild meadow mixed grass plants.

Materials and methods. Allelopathic activity of *A. artemisifolia* was estimated by method of bio testing to seeds of plants. The seeds were pre-disinfected in solution of $KMnO_4$. A green mass of ragweed *A. artemisifolia* was collected, dried to air-dry state and used for the preparation of water-extract for germinating of seeds. We used the water - extraction of the ragweed material (3 g of plant material per 0.25 liters of water (Buzhdygan et al 2015)) to treat seeds of the study agricultural and wild plants during germination. The control samples of the studied species were watered with the distilled water. The experiment lasted 22 days. At the end of the experiment we measured the following morphometric parameters: seed germination, below and aboveground lengths of the seedlings and biomass of the seedlings. The software Statistica 6 have been used for statistical analysis.

Results. Results of the seed germination of the studied species under the effect of the allelopathic substances of *Ambrosia artemisifolia* L. (Fig. 2) showed higher percentage of germination for the most of the study plants plants in the control samples in comparison to the watering with the ragweed extract. However, in the treatment with the *Triticum aestivum* L. and *Hordeum vulgare* L. the germination under the ragweed was higher in comparison to the control plants. However, in case of the *Triticum aestivum* L. the difference was not statistically significant. In addition, the growth of seedlings of *Triticum aestivum* L. in the ragweed treated samples was observed only by the 17-th day of the experiment and then plants died by the end of the experiment, while within the control samples the growth rate remained stable until the end of the experiment. In the treatment with the *H. vulgare* we found the significantly higher germination rates comparing to the other samples under the ragweed treatment. Thereby, our analysis shows the *Hordeum vulgare* to be the most resistant to ragweed water-soluble allelopatic substances. Our results are consistent with the previous findings on how spread of ragweed in the barley crops (Bogoslovskaja, 2011).

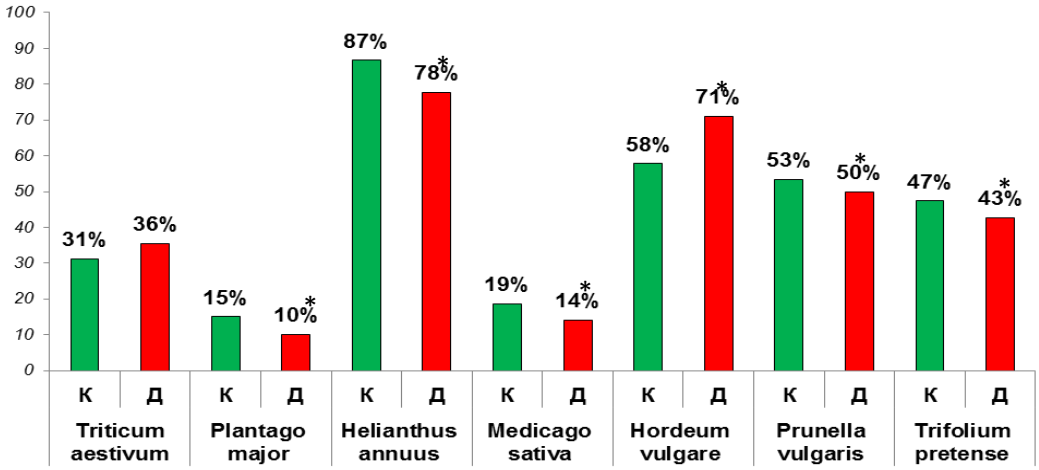

Fig. 2. The percentage of germination of the studied species under the influence of Ambrosia artemisifolia L. (Д-treatment by water-soluble allelopathic substances of ragweed) and the absence of ragweed treatment (К-control)

*Note: * - The difference between the ragweed treatment and control is statistically significant at P <0.05.*

The results on the length of seedling of the studied plants showed decrease in their growth under the ragweed exposure (Table. 1). The rates of total, below- and aboveground biomass of seedlings (Table. 2) were less sensitive to the effects of allelopatic substances of the ragweed compared to the length of seedlings (Table. 1). In the treatment with the *M. sativa* we observed the decrease in the total length of seedlings compared to the control (Table. 1). However, there were no significant differences in the length of the aboveground part of seedlings in the ragweed treated pots compared to the control.

Table 1.

Length of the seedlings of agricultural and wild meadow plants under the influence of ragweed extract (R-treatment by water-soluble allelopathic substances of ragweed) and the absence of ragweed treatment (C-control)

Plant species under study:	Control / Ragweed treatment	lengths, mm		
		total	belowground	aboveground
Species of wild meadow mixed grass plants				
Prunella vulgaris L.	C	2.5±0.4	1.13±0.2	1.33±0.2
	R	3.2±0.6	1.56±0.6*	1.60±0.1
Plantago major L.	C	1.6±0.4	0.5±0.03	1.13±0.7
	R	0.9±0.1*	0.26±0.04*	0.6±0.09*
Species of agricultural five perennial grasses				
Triticum aestivum Linn.	C	42.1±4.6	18.1±1.6	24.1±3.1
	R	38.2±2.9	14.4±1.9*	23.7±2.4
Helianthus annuus L.	C	16.4±1.7	8.3±0.9	8.1±1.3
	R	16.4±1.2	7.6±1.4*	8.9±1.6
Hordeum vulgare L.	C	30.8±1.2	14.0±2.1	16.7±2.2
	R	28.2±4.1	10.9±2.7	17.3±3.8*
Medicago sativa L.	C	5.1±0.9	1.54±0.4	3.56±0.9
	R	3.3±0.8*	1.20±0.3	2.13±0.6*
Trifolium pretense L.	C	5.8±1.1	1.26±0.2	4.54±0.9
	R	5.6±0.9	1.32±0.4	4.31±0.8*

*Note: * - The difference between the ragweed treatment and control is statistically significant at P <0.05.*

We found slight decrease in the total biomass, as well as belowground and aboveground biomass of seedlings under the influence of water-soluble allelopatic substances of ragweed (tab. 2). In the treatments with the *Trifolium pretense* we found a little response of the morphometric parameters of seedlings to the impact of the *A. artemisiifolia*. The length of the aboveground parts of seedlings in the ragweed samples was significantly higher compared to the control sample (Table. 1), but root biomass of *T. pretense* in the ragweed and control treatments remained almost at the same level (Table. 2).

Our results show that in treatments with the *Triticum aestivum* only root parameters were significantly affected by the treatment by water extraction of the ragweed, where both root length and root mass were lower under the effect of ragweed (Table. 1-2). We observed the similar results in the treatments with the *Helianthus annuus*. The watering by ambrosia extract inhibited the growth of the belowground parts of seedlings and resulted in significantly lower values of length (Table. 1) and weight (Table. 1) of the roots. Despite of the significantly higher growth rate of *H. vulgare* under the influence of ragweed, the length and weight of seedlings were significantly higher only for aboveground part of seedlings (Table. 1-2).

Our results show *P. vulgaris* to be stable to the influence of the allelopathic substances of *A. artemisifolia*. In the ragweed treatments the root length of *P. vulgaris* was statistically higher in comparison to watering by distillated water (Table. 1). Both, above- and belowground biomass of seedlings of *P. vulgaris* were not affected by the ragweed (Table. 2). In the treatments of *P.major* we observed slightly different pattern, as follows: the biomass of seedlings was not affected by the ragweed, while above- and belowground biomass were statistically lower under the ragweed influence.

Table 2.

Biomass of the seedlings of agricultural and wild meadow plants under the influence of ragweed extract (R-treatment by water-soluble allelopathic substances of ragweed) and the absence of ragweed treatment (C-control)

Plant species under study:	Control / Ragweed treatment	Biomass, g		
		total	belowground	aboveground
Species of wild meadow mixed grass plants				
Prunella vulgaris L.	C	0.006±0.001	0.001±0.0004	0.005±0.001
	R	0.006±0.001	0.001±0.0008	0.005±0.001
Plantago major L.	C	0.003±0.08	0.001±0.0004	0.002±0.0009
	R	0.003±0.0009	0.001±0.0007	0.002±0.0001
Species of agricultural five perennial grasses				
Triticum aestivum Linn.	C	0.19±0.06	0.08±0.009	0.12±0.03
	R	0.19±0.07	0.05±0.007*	0.14±0.06
Helianthus annuus L.	C	0.37±0.08	0.06±0.08	0.31±0.04
	R	0.42±0.08	0.05±0.006*	0.37±0.09
Hordeum vulgare L.	C	0.18±0.04	0.08±0.009	0.1±0.02
	R	0.2±0.06	0.07±0.006	0.13±0.04*
Medicago sativa L.	C	0.016±0.004	0.001±0.0005	0.015±0.004
	R	0.013±0.003*	0.001±0.0004*	0.012±0.003*
Trifolium pretense L.	C	0.023±0.006	0.002±0.001	0.021±0.005
	R	0.023±0.005	0.0018±0.001*	0.021±0.005

*Note: * - The difference between the ragweed treatment and control is statistically significant at P <0.05.*

Conclusions. The results of experiments demonstrate the strong alleiopathic activity of *Ambrosia artemisifolia* L. Significantly lower seed germination of the following species under the effect of the water-soluble allelopathic substances of ragweed has been demonstrated for the species of *Helianthus annuus*, *Medicago sativa*, *Trifolium pretense*, *Prunella vulgaris*, and *Plantago major*. However, *Hordeum vulgare* has shown significantly higher seed germination under the effect of *Ambrosia artemisifolia* L. Less sensitivity of the seedling biomass in comparison to the seedling length has been demonstrated for the study species under the effect of the allelopathic substances of *Ambrosia artemisifolia*. Phytocoenotic compatibilities of the studied cultural and wild-growing plants with the ragweed allelopathic activity are as following descending orders:

- due to the seed germination:
  Hordeum vulgare > Triticum aestivum > Helianthus annuus > Plantago major = Medicago sativa = Trifolium pretense > Prunella vulgaris
- due to the seed length:
  Triticum aestivum > Hordeum vulgare > Helianthus annuus > Trifolium pretense > Medicago sativa = Prunella vulgaris > Plantago major
- due to the seedling biomass :
  Helianthus annuus > Hordeum vulgare > Triticum aestivum > Trifolium pretense > Medicago sativa = Prunella vulgaris > Plantago major

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ОСОБЛИВОСТІ РОЗВИТКУ ЛУЧНИХ ТА АГРАРНИХ РОСЛИН ЗА ДІЇ АМБРОЗІЇ

О. Я. Буждиган, О. В. Баглей

Алелопатичний вплив амброзії щодо інших видів залишається недостатньо вивченим, що ускладнює наше розуміння про фітоценотичну сумісність цього карантинного виду з іншими культурними та дикорослими видами. Робота присвячена оцінці алелопатичного впливу карантинного виду Ambrosia artemisifolia L. на ріст та розвиток п'яти видів широко використовуваних у сільському господарстві в Україні культурних багаторічних трав та двох видів дикорослих лучних різнотравних рослин. Встановлено достовірно нижчий відсоток проростання насіння за дії водорозчинних алелопатичних речовин амброзії полинолистої таких видів як: Helianthus annuus L., Medicago sativa L., Trifolium pretense L., Prunella vulgaris L., та Plantago major L.; та достовірно вищий відсоток проростання насіння виду Hordeum vulgare L. Показники маси проростків виявилися менш чутливим до впливу водорозчинних алелопатичних речовин амброзії в порівнянні з показниками довжини проростків. Побудовано ряди спадання фітоценотичної сумісності досліджуваних культурних багаторічних трав та дикорослих лучних різнотравних рослин до алелопатичної активності амброзії полинолистої.

Ключові слова: амброзія полинолиста, алелопатія, карантинний вид, культурні рослини, дикорослі рослини, морфометричні параметри.

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