AgroLife Scientific Journal - Volume 10, Number 1, 2021
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

ALLELOPATHIC PROPERTIES OF WINTER WHEAT VARIETIES OF VARIOUS BREEDING INSTITUTIONS OF UKRAINE

Margaryta KORKHOVA, Vira MYKOLAICHUK

Mykolaiv National Agrarian University, Mykolaiv, 9 Heorhiia Honhadze Street, 54000, Ukraine, Phone: 380512340136, Email: korhovamm@mnau.edu.ua

Corresponding author email: korhovamm@mnau.edu.ua

Abstract

The article presents the results of scientific research on the influence of water extracts of root secretions of winter wheat varieties on seed germination and root growth of single-leaf cress seedlings. Soil samples from the rhizosphere zone of plants of the studied winter wheat varieties were selected in the phases of flowering and full ripeness of the grain. Water extracts of soil at a concentration of 1: 100 were prepared for the Biotest. The findings showed that the stimulatory and inhibitory action of water extracts of root excretions of plants of winter wheat on seed germination and growth of seedlings one-day watercress depending on the varietal characteristics and phases of development. In the flowering phase of plants, water extracts of root secretions of all the studied varieties negatively affected on the germination of test culture seeds. It was found that the Kvitka poliv variety in the phase of full grain ripeness activated the germination of cress seeds. Water extracts of the soil of root secretions of soft winter wheat varieties Vidrada and Krasa paniv were determined to be neutral to the germination of cress seeds.

Key words*: allelopathic action, winter wheat, varieties, watercress, seed germination.*

INTRODUCTION

One of the most important tasks of modern science is to solve the problem of biologization of agriculture, to increase the profitability and stability of agrophytocenosis, and to obtain stable yields of high-quality products. When developing the structure of crop rotations and mixed crops, in order to prevent soil fatigue in monoculture, weed control, phytopathogenic organisms, and the like, take into account the phenomenon of allelopathy or chemical interaction of plants, which was first discovered by the German scientist G. Molish in 1937 (Willis, 2010; Shinde & Salve, 2019).

Allelopathy as a scientific direction, due to the breadth and versatility of its approaches to the study of various biological phenomena, is intensively developing all over the world, including in Ukraine (Kucheriavyi, 2018; Shao et al., 2019; Li et al., 2019; Andrianandrasana et al., 2020).

In recent years, due to the increase in the area of organic land, the need for alternative methods of weed control is becoming more acute (Saracin & Vasile, 2015; Murimva et al., 2019).

Studies of many scientists have found that allelopathic culture can potentially be used to control clogging, seeding a variety with allelopathic properties, thereby reducing the rate of use of synthetic herbicides (Stephen, 2015; Nikneshan et al., 2011; Cheema et al., 2007; Iqbal, 2020). Soft winter wheat is one of the most common agricultural crops in the world and has allelopathic potential for controlling weeds, pests and diseases, which contributes to its cultivation using organic technologies (Sangeetha & Baskar, 2015; Schalchli et al., 2012; Ming et al., 2020). The allelopathic activity of wheat has been attributed to hydroxamic acids, the related compounds and phenolic acids (Lam et al., 2012).

According to Derevyanko V.A. (2007), the phyto-immunity of wheat plants largely depends on the allelopathic regime of the soil, because permanent cultivation of cultivated plants in one place leads to inhibition of growth and reduced resistance to diseases and pests.

Studies of various scientists found that wheat varieties had different allelopathic properties against weeds (Wu By et al., 2001; Zuo et al., 2011; Petcu et al., 2017).

When alternating different varieties of winter wheat, the yield reduction in the monoculture will be significantly less than when growing a single variety for a long time (Derevyanko, 2003). Today, research, testing and selection of winter wheat varieties with a high potential for organic cultivation are relevant, but the allelopathic properties of these varieties are not always taken into account.

Therefore, the aim of the work was to study the allelopathic properties of 9 varieties of winter wheat in various breeding centers of Ukraine.

MATERIALS AND METHODS

The method of Grodzinsky A.M. (1973) was used to establish the allelopathic action of winter wheat varieties that were promising for the Steppe zone of Ukraine).

The test culture was single-leaf cress sprouts (*Lepidium sativum* L.).

Soil samples were taken directly in the rhizosphere zone during the stages of earing and full ripeness of winter wheat grain. It was studied the influence of water extracts on the germination and length of the roots of seedlings.

The ratio of soil weight to distilled water is 1: 100. The experience was laid in a 10-time repetition. The studies were performed in laboratory conditions at a temperature of 23°C.

The material for the study was 10 varieties of winter wheat bred in different soil and climate zones of Ukraine (Table 1).

Table 1. Characteristics of winter wheat varieties (*T. aestivum* L. and *T. spelta* L.) of various breeding institutions in Ukraine

Botanical taxon	Variety denomination	Owner	Registration year	Recommended zones for growing
T. aestivum L.	Vidrada	Bilotserkivska Experimental Breeding Station	2010	Steppe, Forest-Steppe, Polissya
T. aestivum L.	Koshova	Institute of Irrigated Agriculture	2017	Steppe, Forest-Steppe
T. aestivum L.	Schedrivka kyivs'ka	V. M. Remeslo Myronivka Institute of wheat	2016	Steppe
T. aestivum L.	Krasa laniv	Plant Production Institute nd. V. Va. Yuryev of NAAS	2017	Steppe, Forest-Steppe, Polissya
T. aestivum L.	Kvitka poliv	Bilotserkivska Experimental Breeding Station	2018	Steppe, Forest-Steppe, Polissya
T. aestivum L.	MIP Assol'	V. M. Remeslo Myronivka Institute of wheat	2018	Forest-Steppe
T. aestivum L.	Harantiia odes'ka	Selection and Genetics Institute - National Center of Seed and Cultivar	2015	Steppe, Forest-Steppe
T. aestivum L.	Schedrist' odes'ka	Selection and Genetics Institute - National Center of Seed and Cultivar	2014	Steppe, Forest-Steppe
T. spelta L.	Zoria Ukrainy	Ukrainian Scientific Institute of Plant Breeding	2012	Steppe, Forest-Steppe, Polissya

The control variant was single-leaf cress sprouts sprouted on distilled water. Field research was carried out during 2019-2020 years on the experimental field of the Educational, Scientific and Practical Center of the Mykolaiv National Agrarian University. The variants were placed in the experiment by the method of split plots, the repetition of the experiment was fourfold. The area of the registration area was 25 m². Soil of research areas was southern black soil humus, light clay-loam soil on wide slightly drained loess on the watershed plateau, typical for the area of Southern Steppe. Their arable layer contains an average of 2.4% humus, light-hydrolyzed nitrogen as 16 mg/kg, mobile phosphorus as 160 mg/kg and exchanged potassium as 187 mg/kg of soil. Mathematical and statistical data processing was carried out by the method of dispersion analysis using computer programs "Microsoft Excel 2013" and "Agrostat".

RESULTS AND DISCUSSIONS

According to the results of research, it was found that water extracts of root secretions of plants of the studied winter wheat varieties had a significant effect on the germination of cress seeds, depending on the development phase. Thus, during the flowering phase of plants,

water extracts from the soil in the rhizosphere zone of winter wheat plants of all the studied varieties negatively affected the germination of cress seeds. It was determined that low seed determined that low seed germination of test plants (44.0%) were in variants of treatment with the extract of water extract from varieties Schedrist' odes'ka. This was 28% was less than control (Table 2).

Table 2. Influence of water extracts of the rhizosphere soil of winter wheat plants on the germination of cress seeds, %

Variety	Phase of plant development			
	Flowering	+; - control, %	full ripeness	+- control, %
Control	72.0	-	72.0	-
Vidrada	48.2	-23.8	35.1	-36.9
Koshova	56.4	-15.6	67.2	-4.8
Schedrivka kyivs'ka	46.0	-26.0	29.4	-42.6
Krasa laniv	60.2	-11.8	53.0	-19.0
Kvitka poliv	47.8	-24.2	75.2	+3.2
MIP Assol'	57.0	-15.0	37.6	-34.4
Harantiia odes'ka	47.2	-24.8	26.3	-45.7
Schedrist' odes'ka	44.0	-28.0	25.8	-46.2
Zoria Ukrainy	45.7	-26.3	26.0	-46.0

Krasa laniv had a lesser inhibitory effect on the germination of cress seeds, which was 11.8% less than the control. In the phase of full ripeness of winter wheat grain, there was a negative effect on the germination of seeds of water extracts of the soil of most of the studied varieties, except for Kvitka poliv, which had a slight stimulating effect (+3.2% to control). It was found that a significant decrease in germination of test culture seeds in comparison with the control was observed in variants with the varieties Schedrivka kyivs'ka (-42.6%), Harantiia odes'ka (-45.7%), Zoria Ukraine (-46.0%) and Schedrist' odes'ka (-46.2%).

As a result of researches it was established the allelopathic effect of root excretions of plants of various varieties of winter wheat in the flowering stage, which was in the range from modestly stimulatory to inhibitory. Slight stimulating effect is typical for Krasa laniv and Vidrada varieties (0.52% and 0.39%, respectively). The greatest inhibitory effect is caused by root secretions of varieties Harantiia odes'ka and Kvitka poliv (-37.6% and -39.28%, respectively) (Figure 1).

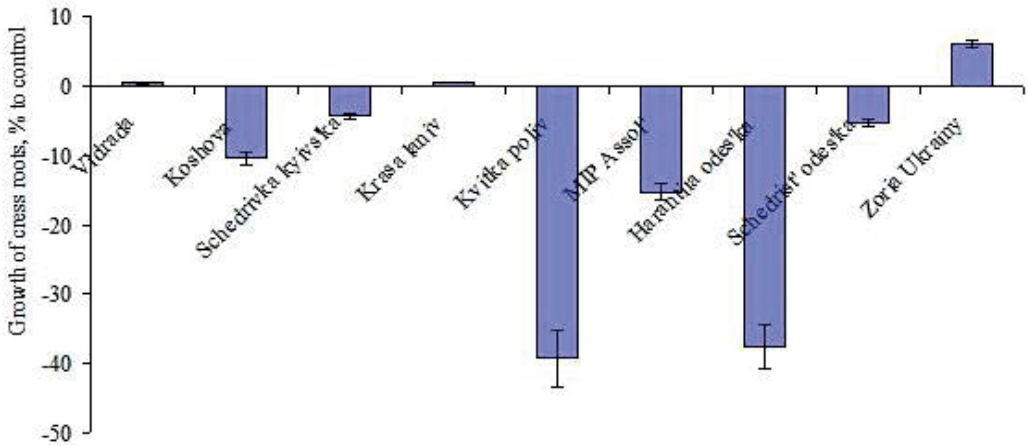

Figure 1. Allelopathic soil activity in the rhizosphere zone of winter wheat plants in the flowering phase, depending on the variety (relative to the control), %

Spelt wheat of the Zoria Ukrainy variety is characterized by a low (up to 10%) allelopathic activity in this phase. It was proved that allelopathic effect of root excretions in aging plants increased (Mozdzen & Repka, 2014). Our research found that in the phase of grain full ripeness that the root excretions of plants of six studied varieties of winter wheat were stimulating allelopathic action, which ranged from negligible (2.56%) of the variety Vidrada to substantial (66.87%) varieties Kvitka poliv (Figure 2).

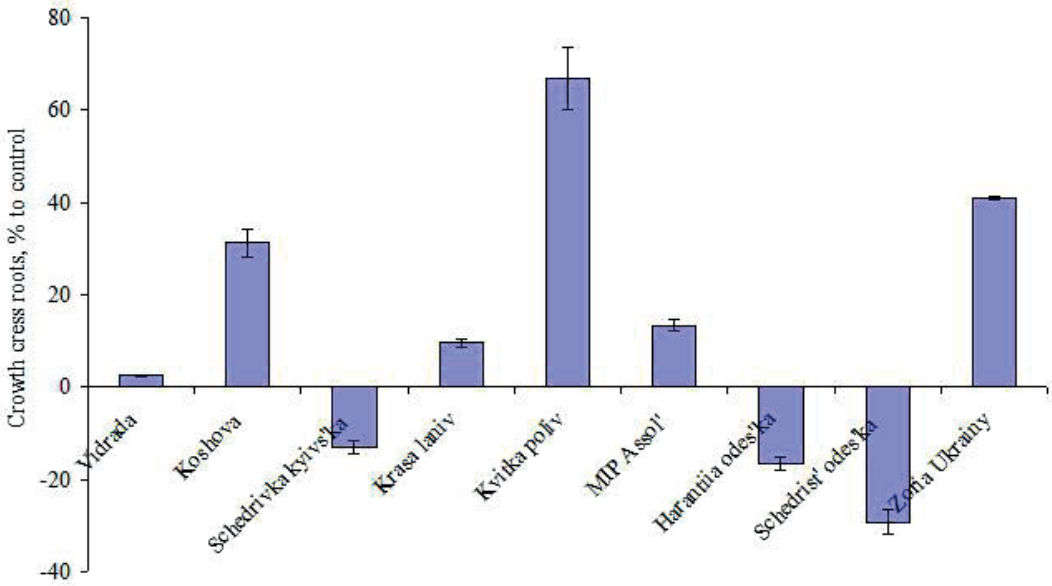

Figure 2. Allelopathic soil activity in the zone of rhizosphere of plants of various varieties of winter wheat in the phase of full ripeness (relative to control), %

It was found a high stimulating effect of root secretions of winter wheat spelt of the variety Zorya Ukrainy (41.03%) on the growth of roots of the test culture, which exceeded this indicator of all the studied varieties of soft wheat, except for the variety Kvitka poliv.

In Soft winter wheat varieties Shchedrovka kyivs'kaya, Harantiia odes'ka and Schedrist' odes'ka it was found an inhibiting effect on the growth of cress roots - from -29.25% up to -12.99%.

Analyzing the amplitude of the allelopathic action of root secretions of winter wheat plants, we found that the highest indicator was characteristic of the variety Kvitka poliv as 106.15 % (Figure 3).

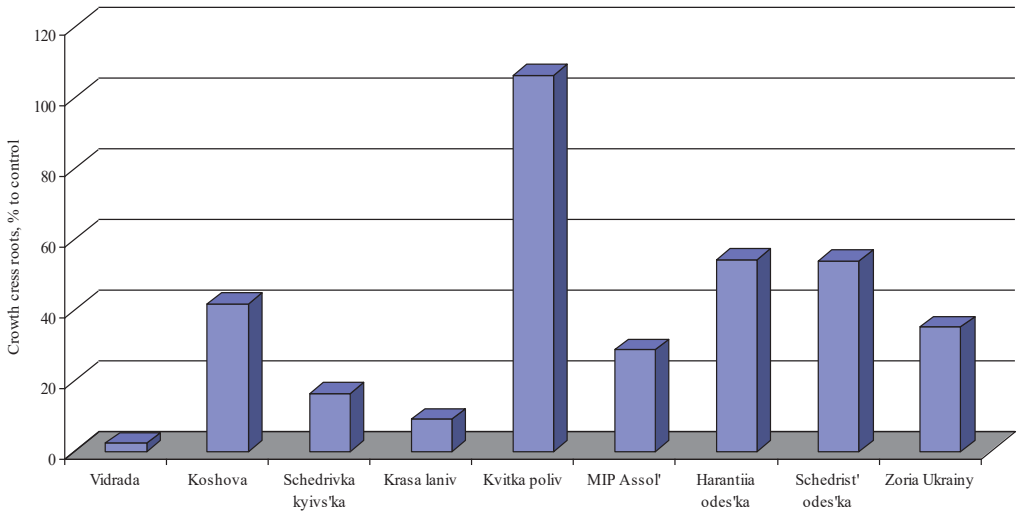

Figure 3. Amplitude of allelopathic activity of soil in the rhizosphere zone of winter wheat plants depending on the studied growth and development phases, %

The lowest indicator of the amplitude of allelopathic activity is characteristic of root cells plant secretions of soft winter wheat varieties Vidrada and Krasa laniv (2.17% and 9.05%, respectively, that is, they are tolerant compared to other varieties. For wheat spelt varieties Zorya Ukrainy, allelopathic activity of root excretions has a high amplitude (34.98%), which is by 6.40%; 18.59%; 25.93%, 32.81% higher than for the varieties MIP Assol', Schedrivka kyivs'ka, Krasa laniv and Vidrada in accordance.

CONCLUSIONS

By results of the conducted researches it was established that the nature of the metabolites of the investigated winter wheat varieties that secreted in the area of the rhizosphere of the plants they had stimulatory and inhibitory action on seed germination and growth of seedlings of cress, depending on the varietal characteristics and phases of development. The germination of cress seeds is negatively affected by root secretions of all the studied varieties of winter wheat, except for the Kvitka poliv variety, which has a slight stimulating effect in the phase of full ripeness. In the flowering phase of plants of the same variety, the greatest inhibitory effect of root secretions was recorded (-39.28%) on single-leaf seedlings of the test-culture, and in the full ripeness phase it was recorded the maximum activating effect (66.87%). It can be assumed that the allelopathically active substances which secrete by the roots of wheat plants of soft winter varieties Vidrada and Krasa laniv are neutral to the germination of cress seeds, which requires further research of these varieties on other test-culture.

REFERENCES

Andrianandrasana, M.D., Andry Mihajamanana, N., Rakotojoseph, F., Baohanta, R.H., Randriambanona, H., Cornea, C.P., Khasa D., Ramanankierana, H. (2020). Allelopathic effects of *Grevillea banksii* R. BR. Leaf extracts and its rhizospheric soil on germination and initial growth of three agricultural crops in Madagascar. *AgroLife Scientific Journal*, 9(1), 23-30.

Cheema, Z.A., Khaliq, A., Abbas, M., Farooq, M. (2007). Allelopathic potential of sorghum (*Sorghum bicolor* L. Moench) cultivars for weed management. *Allelopathy journal*, 20 (1), 167-178.

Derevyanko, V.A. (2003). Species through the prism of the conception of allelopathic parameters. *Plant introduction,* 4, 129-133.

Derevyanko, V.A. (2007). Allelopathic activity of *Triticum* L. Species and varieties. *Plant introduction,* 4, 112-116.

Iqbal, J., Rehmani, M.I.A., Sagheer, S., Kaleem, N., Muneer, J. (2020). Herbicidal potential of some dry land plants against *Lathyrus aphaca* (L.), winter season weed. *Planta daninha*. 38, 1-7.

Grodzinskiy, A.M. (1973). The fundamentals of chemical interaction of plants. Kyiv: *Scientific thought*, 205 p.

Kucheriavyi, O. (2018). Development of scientific activities of the allelopathial department of M. M. Grishko's National Botanical Garden of NAS of Ukraine (1960-2005). *History of science and biographical studies*, 4(13), 203-216.

Lam, Y., Sze, C.W., Tong, Y., Ng, T.B., Tang, S.C.W., Man, Ho J. C., Xiang, Q., Lin, X., Zhang, Y. (2012). Research on the allelopathic potential of wheat. *Agricultural Sciences,* 3(8), 979-985.

Li, Z.R., Amist, N., Bai, L.Y., (2019). Allelopathy in sustainable weeds management. *Allelopathy journal*, 48(2), 109-138.

Ming, Y., Zhu, Z.J., Li, J., Hu, G.X., Fan, X.M., Yuan, D.Y. (2020). Allelopathic effects of *Castanea henryi* aqueous extracts on the growth and physiology of *brassica pekinensis* and *Zea mays*. *Chemistry & biodiversity*, 17(6). https://doi.org/10.1002/cbdv.202000438.

Murimwa, J.C., Rugare, G.T., Mabasa, S., Mandumbu, R. (2019). Allelopathic Effects of Aqueous Extracts of Sorghum (*Sorghum bicolor* L. Moench) on the Early Seedling Growth of Sesame (*Sesamum indicum* L.) Varieties and Selected Weeds. *International Journal of Agronomy,* 1-12.

Nikneshan, P., Karimmojeni, H., Moghanibashi, M., Hosseini, N.A. (2011). Allelopathic potential of sunflower on weed management in safflower and wheat. *Australian journal of crop science*, 5(11), 1434-1440.

Petcu, E., Babeanu, N., Popa, O. (2017). Screening methods for evaluating the allelopathic potential of wheat and triticale genotypes. *Scientific Papers-Series A-Agronomy*, 60, 370-374.

Sangeetha, C., Baskar, P. (2015). Allelopathy in weed management: A critical review. African Journal of *Agricultural research*, 10(9), 1004-1015.

Saracin, V.C., Vasile, A. (2015). An exploratory research regarding Romanian organic farming sector. *AgroLife Scientific Journal*, 4(2), 119-123.

Schalchli. H., Pardo, F., Hormazabal, E., Palma, R., Guerrero, J., Bensch, E. (2012). Antifungal activity of wheat root exudate extracts on *Gaeumannomyces graminis* var. tritici growth. *Journal of soil science and plant nutrition,* 12 (2), 329-337.

Shao, G.G., Li, W.Y., Yan, S.H., Zhang, C.Y., Huang, S.C., Ren, L.T., (2019). Allelopathic effects of different weed extracts on seed germination and seedling growth of wheat. *Pakistan journal of botany,* 51(6), 2159-2167.

Shinde, M.A., Salve, J.T. (2019). Allelopathic effects of weeds on *Triticum aestivum.* International Journal of Engineering *Science and Computing,* 9(2), 19873-19876.

Stephen, O.D. (2015). Proving allelopathy in crop-weed interactions. *Weed Science*, Special Issue, 121-132.

Willis, R.J. (2010). The History of Allelopathy. Dordrecht, Netherlands: Springer, 316 p.

Wu, By H., Pratley, J., Lemerle, D., Haig, T. (2001). Allelopathy in wheat (*Triticum aestivum*). *Association of Applied Biologists*, 139, 1-9.

Zuo, S.P., Ye, L.T., Mei, H. (2011). Physiological basis for allelopathic potential of different wheat cultivars in heading period on the Loess Plateau of China. *African journal of biotechnology*, 10(48), 9786-9795.