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WEED CHEMICAL CONTROL IN THE WINTER WHEAT PLANTING AFTER NON FALLOW PREDECESSORS IN THE NORTHERN STEPPE OF UKRAINE

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Abstract

The use of alfalfa as predecessors for winter wheat leads to the increase of weed infestation of its cultivation in the result of frequent cutting out of the culture during three years of use. It was shown that of winter wheat yields have had a higher level of weed infestation after non fallow predecessors with inadequate coverage of soil surface. Therefore they demand high-priority protection from weed sprouts. None of the studied herbicides was able to provide reliable protection of wheat crops from bromes (Bromus tectorum L.), as well as a sticky weed (Galium aparine L.). The tank mix of herbicides (Esteron – 0.8 l/ha + Puma Super – 0.8 l/ha) provides a reliable protection for winter wheat crops from many types of short-lasting weeds including the cattail grass (Setaria pumila L.), water grass (Echinochloa crus-galli L.). A significant suppressive effect on cereal weeds Super was registered for the herbicide Ellay.

Key words: *winter wheat, weeds, herbicides, grain yield.*

INTRODUCTION

Winter wheat distinguishes with high productivity and relates to the plants with high ability to suppress weeds especially due to its cultivation after the best predecessors (clean, early, occupied fallow, perennial herbs, pea, etc.) and growing by intensive technologies (Toigildinv et al, 2016; Gerdzhikova, 2014; Stagnari et al., 2017). A considerable part of winter wheat plantings is cultivated after non fallow crops (sunflowers, stubble cereals) in the result of changing priorities of management, technologies, crop rotation and cropping system.

Depending on the species composition and density of weeds in the crops, delays with the measures to limit harmfulness of weeds may lead to losses of winter wheat grain yield from 40 to 100 % It is a well-known fact that weeds are transmitters of diseases and pests, they complicate the process of crop harvesting and increase costs on product cleaning and drying (Durgan and Gunsolus, 2013; Shaner and Beckie, 2014). Therefore, it is important promptly to carry out recommended different activities on weeds control in order to obtain a planned and quality grain harvest in time (Hossein and Ismail, 2018; Hossard et al, 2014; Varshney et al, 2012; Ashiq et al., 2007).

The main criteria and arguments due to the herbicide assortment organization are high biological efficiency against a wide variety of weeds, an increased selectivity to cultivation, maximum independence on weather, a wide variety of terms of use, adaptability, security for personnel and environment, the absence of after-action on sensitive crops, and affordable cost of each chemical (Barberi et al, 2010; Benoit et al. 2004; José-Maria and Sans, 2011; Tsyliuryk et al., 2017). All above-mentioned features are appropriate for sulfonylureas (El-Kholy, 2013; Arif et al., 2004; Pacanoski and Mehmeti, 2018).

High activity of sulfonylureas and their significant selectivity allow applying these substances in chemical weeds withdrawal on cereal fields (barley, wheat) and other crops. Analysis of technical and economic efficiency of sulfonylurea drugs in the field conditions showed that cereals are high resistant from the stage of the two leaves before their transformation into a tube (Ferreira et al., 1990). The most effective is achieved in case of spraying of young actively growing weeds. Effectiveness of sulfonylureas does not depend on weather conditions (Song et al., 2004; Khan et al., 2003). Technical crops treatment can be carried out with these chemicals with a temperature of 5 °C that determines their larger choice of terms and applications (Yin et al., 2008; Hamada et al., 2013).

Tank mixes of sulfonylurea substances are highly effective and selective (Tkalich et al., 2018). On the other hand, there is a fact of after-action of herbicides not only on weeds but on culture plants in the field conditions too. It is important to use mixed combinations of industrial production or tank with the addition of already known substances such as chlorsulfuron or triasulfuron in the form of small additions to other herbicides (Dalga et al., 2014; Modhej and Kaihani, 2013).

The main objective of the research are to determine a biological efficiency of derivative sulfonylureas herbicides and their tank mixes for the protection of winter wheat crops from weeds in the Steppe zone of Ukraine.

MATERIALS AND METHODS

The experiment regarding efficiency of tank mixes and economic threshold of harmfulness of weeds (ETH) was carried out in 2014-2017 with winter wheat ("Spivanka" variety) in the field crop rotation of State Enterprise "Dnipro" of the State Institute of Grain Culture of the Agricultural Science National Academy of Ukraine (Dnipropetrovsk region). Alfalfa, feeding vetch and oat mix were predecessors for winter wheat. Generally, during the years of the experiment, weather conditions were favorable for the growing and development of plants. The soil of the experiment was ordinary, low-humic and hard-loamy chernozem (Kharytonov et al., 2016). The perennial weeds (field bindweed, blue lettuce, field thistle and field milk thistle) characterized average density (25-42000 pcs/m^2). Short-annual seeds have got high density (310-460 million pcs/m^2) .The scheme of the experiment to study the biological efficiency of herbicides on the background of the two predecessors (alfalfa, mix of vetch and oats) included 10 trials: a) control (without herbicides); b) Granstar - 25 g/ha; c) Esteron 60-0.6 l/ha; d) Banvel 4C - 0.3 l/ha;e) Grodyl Maxi - 100 ml/ha; f) Ellay Super - 0.3 l/ha + PAR Trend 90-0.3 l/ha; g) Esteron - 0.8 l/ha; h) Esteron - 0.8 l/ha + Puma super - 0.8 l/ha; i) Mastak - 0.5 l/ha; j) Granstar Gold - 18 g/ha. Herbicides and their tank mixes were applied by spraying along consumption rate of spray solution in amount of 250-300 l/ha. The plot area of the experiment was 100 m^2 (20 m × 5 m), accountable is 43 m^2 triple repeatability. Accountability of weed infestation was undertaken before herbicide application, after 30 days of the treatment and before winter wheat crops harvesting. Efficiency of the herbicides which were used to protect the grain yields from weeds was calculated by formula:

$$E=100\% - \left(\frac{K2}{K1}\right)\times 100,\ (\%), \quad (1)$$

where:

E - part of eliminated weeds of the total number in the yields before spraying process, %;

K_2 - a number of weeds in the winter wheat plantings in case of the maximum effect of the applied herbicide, pcs/m^2;

K_1 - amount of weeds in crops sowing before the spraying process, pcs/m^2.

A new methodology of the ETH determination was developed: a) from 50% to 84% - inadequate coverage; b) from 85% to 95% - adequate coverage; c) from 96% and more - best coverage.

RESULTS AND DISCUSSIONS

It was established that underdeveloped plants of winter wheat are formed after non fallow predecessors, especially in dry years with lack of autumn precipitations. The full projective cover of the ground surface in next spring period occurs on the level of 35-45%, encourages the increase of lower layer of plant stand, and affects the increase of weed infestation (Table 1). Sowings after non fallow predecessors were weeded particularly with common ragweed (*Ambrosia artemisiifolia* L.), as well as with white goosefoot (*Chenopodium album* L.). These weeds create a potential threat to the yield reduction. Therefore, they were eliminated at first. Except for these three main weeds, sporadically more 10-12 species of early weeds were found in the crops. The herbicide Esteron 60.85% CU (2-Ethylhexyl ester 2.4-D, 850 g/l) showed the best results regarding to control of common ragweed (*Ambrosia artemisiifolia* L.) and white goosefoot (*Chenopodium album* L.) in three trials.

Table 1. Quantitative and species composition of short - annual weed shoots of winter wheat planting, pcs/m^2

Botanical name of weeds	Agrobiologic group and other features	Density of shoots, (pcs/m^2)	
		Alfalfa	Vetch and oats
Common ragweed (*Ambrosia artemisiifolia* L.)	An early spring annual plant with a late fruitage. Quarantine allergen weed	105.2	73.6
Dropping brome (*Bromus tectorum* L).	An early cereal weed in winter wheat crops, herbicide resistant	18.4	1.3
Purple dead-nettle (*Lamium purpureum* L.)	An annual weed with kidney-shaped leaves: first on the petioles and standing upper	0.1	0.2
Field gromwell (*Lithospermum arvense* L.)	An annual dioecious weed that has winter and spring shape	3.5	0.2
Shepherd's purse (*Capsella bursa-pastoris* L.)	A ruderal weed with winter and spring shapes and a long-term (35 years) grain viability	6.7	2.1
Herb-Sophia (*Descurainia sophia* L.)	An early spring weed with winter and spring shapes	4.6	1.2
Ragworts *(Senecio vernalis* Waldst*)*	A ruderal spring weed able to develop as a winter one	1.3	0.4
Goosefoot *(Chenopodium album* L.*)*	A dioecious early ruderal and segetal weed with a high (up to 700,000) fruitage	67.8	52.5
Sticky weed (*Galium aparine* L.)	A spiniferous plant with climbing stems, herbicide 2.4-D resistant	3.9	0.7
Fumewort (*Fumaria Schleicheri* Soy.)	An annual ruderal spring poisonous weed with pinnatisected leaves	1.2	0.3
Rocket-larkspur (*Consolida arvensis* L., *Delphinium consolida* L.)	Spring or wintering annual weed which infects mainly crops of winter wheat	0.7	0.1
Small tumbleweed mustard (*Sisymbrium loeselii* L.)	Mainly two-year-old ruderal plant, 70-130-centimeter height. It produces a lot of seeds which contaminates soil	0.2	0.0
Field pennycress (*Thlaspi arvense* L.)	An early spring and wintering annual plant	0.4	0.5
Wild buckwheat (*Fallopia convolvulus* L.)	An early ruderal and segetal weed with climbing stems	0.3	0.3
Giant sumpweed (*Cyclachaena xanthiifolia* (Nutt.) Fressen*, Iva xanthiifolia* Nutt.)	An early spring one-year-old, allergen weed with the height of stems from 0.6-0.8 metres to 2.5-3 metres	0.8	0.1
Total:		214.5	133.5

Both destroyed and damaged by the chemical weeds, as well as those which came up of the potential stock of seeds in the soil after spraying were included in the registration.

The data on winter wheat crops infestation before the herbicides application are shown in the Figure 1. The number of vegetative plants of common ragweed (*Ambrosia artemisiifolia* L.) and white goosefoot (*Chenopodium album* L.) in the winter wheat crops was the least after 24 days of the appliance of the herbicide, particularly, at the areas of the experiment (Figure 2).

None of the studied herbicides was able to provide reliable protection of wheat crops from bromes (*Bromus tectorum* L), as well as a sticky weed (*Galium aparine* L.). The tank mix of herbicides (Esteron - 0.8 l/ha + Puma Super - 0.8 g/ha) provides a reliable protection for winter wheat crops from many types of short-lasting weeds including the cattail grass (*Setaria pumila* L.), water grass (*Echinochloa crus-galli* L.). However it does not guarantee proper control of cheatgrass (*Bromus inermis* Leyss L.).

It should be pointed out that after the second register of infestation in the winter wheat crops regarding control (without herbicides), particularly less amount of short-annual shoots of weeds was identified (Figure 3).The density of cheat grass in the winter wheat crops sowed after third year of perennial crops use is gradually increasing during the vegetation period (Figure 4).

An important stage to provide development of winter wheat crops after non fallow predecessors is the time of temporary interruption or remission of biological (technical) influence on weeds by applied herbicides to suppress weeds and prevent their fruitage and regeneration. A malicious quarantine weed common ragweed (*Ambrosia artemisiifolia L.*) created the main agrotype of infestation on the whole herbicide backgrounds even in the conditions of the last register of weed infestation.

An amount of ambrosia plants reached 57.6 pcs/m^2 comparative to control (without herbicides) after the last register of weed infestation. Unfortunately, sustainable control strategies to mitigate its spread into areas not yet invaded and to reduce its abundance in badly infested areas are lacking (Gerber et al., 2011). Application of herbicides and their tank mixes on the winter wheat crops particularly had an effect on grain yield of winter wheat (Figure 5). The highest winter wheat grain yield (6.2 t/ha) was registered in trial h with the appliance of tank herbicide mixes (Esteron - 0.8 l/ha + Puma Super - 0.8 l/ha).

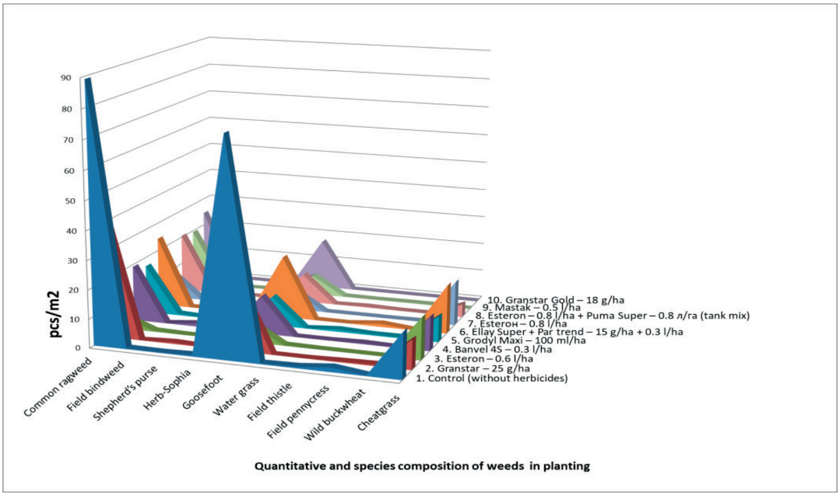

Figure 1. Winter wheat crops infestation before the herbicides application, pcs/m^2

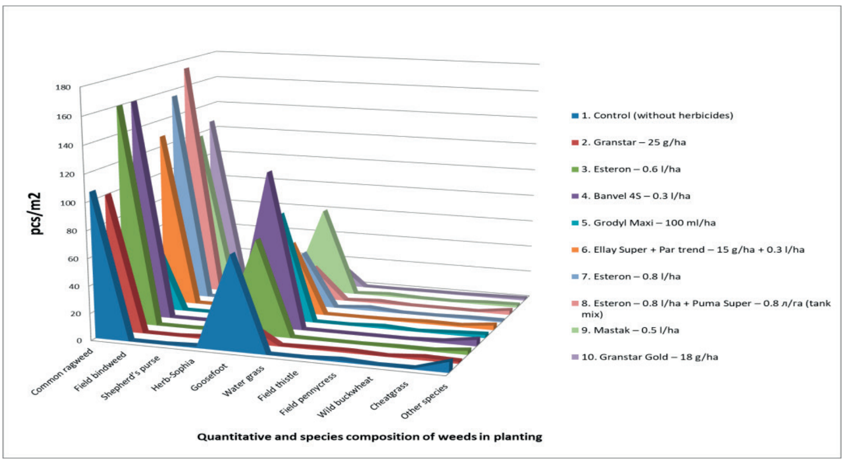

Figure 2. Winter wheat crops infestation in 24 days after the herbicides application, pcs/m^2

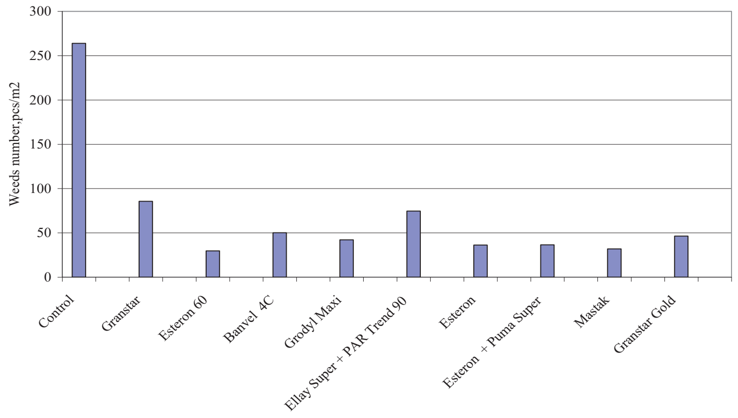

Figure 3. Weed control with herbicide

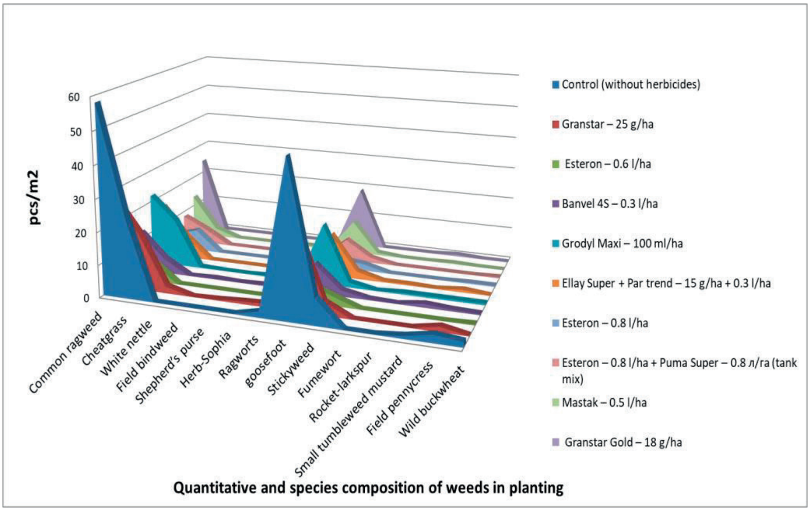

Figure 4. Winter wheat crops infestation before harvesting, pcs/m^2

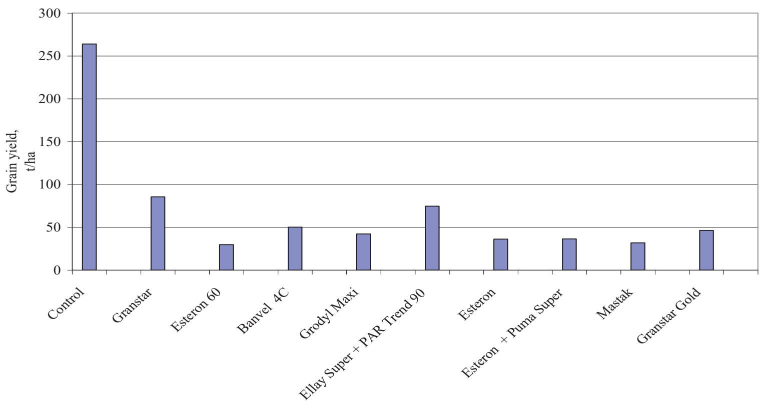

Figure 5. Winter wheat grain yield in the trials with different weed control (2014-2017, t/ha)

Furthermore, during harvesting, the mass of weeds in the air-dried basis was 16 g/m^2. Weeds did not pass to the upper and even middle layer, as well as there were in suppressed state and did not create a threat of crop loses. It should be mentioned also that high winter wheat yield (6.2 t/ha) on the area where the efficacy of herbicide Esteron - 0.8 l/ha was not worse than the tank mix of the trial (Esteron - 0.8 l/ha + Puma Super - 0.8 l/ha). A significant suppressive effect on cereal weeds Super was registered for the herbicide Ellay. Herbicides Granstar (25 g/ha) and Granstar gold (18 g/ha) were ineffective and practically did not stop the growth and development of ragweed (*Ambrosia artemisiifolia* L.) and white quinoa (*Chenopodium album* L.).

It was established that a number of weed shoots per unit area are not always related to their effect on the grain yield. It was shown that of winter wheat yields have had a higher level of weed infestation after non fallow predecessors with inadequate coverage of soil surface. Therefore they demand high-priority protection from weed sprouts. In general, the problem of effective protection from weeds of winter wheat after non fallow predecessors minimises to solving of the two main objectives which are to prevent seed bank growth of their short-annual species and vegetative regeneration of perennial rooted weeds.

CONCLUSIONS

The use of alfalfa as a predecessor for winter wheat leads to the increase of weed infestation of its cultivation in the result of frequent cutting out of the culture during three years of use, its gradual "drop-out" from agrocenosis and filling ecological niche with harmful weeds in the result of lower layer lightness of crops stands especially rooted and rooted-stem species. Highest level of weeds control was provided due to the herbicide Esteron 60.85% CU (2-Ethylhexyl ester 2,4-D, 850 g/l) both in individual and tank mixed application (Esteron - 0.8 l/ha + Puma Super - 0.8 l/ha).

The maximum winter wheat yield was registered in trial with tank mixes of herbicides (Esteron - 0.8 l/ha + Puma Super - 0.8 l/ha) - 6.2 t/ha.

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REFERENCES

Arif, M., Awan, I.U., Khan, H.U. (2004). Weed management strategies in wheat (*Triticum aestevum* L.). *Pak. J. Weed Sci. Res., 10*(1-2), 11–16.

Ashiq, M., Muhammad, N., Ahmad, N. (2007). Comparative efficacy of different herbicides against broad leaf weeds in wheat. *Pak. J. Weed Sci., 13*(3-4), 149–156.

Bàrberi, P., Bburgio, G., Dinelli, G., Moonen, A.C., Otto, S., Vazzana, C., Zanin, G. (2010). Functional biodiversity in the agricultural landscape: relationships between weeds and arthropod fauna. *Weed Research*, *50*, 388–401.

Benoit, D.L., Kenkel, N.C., Cavers, P.B. (2004). Factors influencing the precision of soil seed bank estimate. *Canadian Journal of Botany*, *67*, 2833–2840.

Dalga, D., Sharma, J., Tana, T. (2014). Evaluation of Herbicides and Their Combinations for Weed Management in Bread Wheat (*Triticum Aestivum* L.). *International Journal of Novel Research in Life Sciences, 1*(1), 31–47.

Durgan, B.R., Gunsolus, J.L. (2013). Developing weed management strategies that address weed species shifts and herbicide resistant weeds on wheat crop. *Extension Weed Scientists,* Department of Agronomy and Plant Genetics University of Minnesota, 23–31.

El-Kholy, R.M.A., Abouamer, W.L., Ayoub, M.M. (2013). Efficacy of some herbicides for controlling broad-leaved weeds in wheat fields. *Journal of Applied Sciences Research*, *9*(1), 945–951.

Ferreira, K. L., Baker, T.K., Peeper, T.F. (1990) Factors Influencing Winter Wheat (*Triticum aestivum*) Injury from Sulfonylurea Herbicides. *Weed Technology, 4*(4), 724–730.

Gerber, E., Schaffner, U., Gassmann, A., Hinz, H.L., Seier, M., Müller-Schärer, H. (2011). Prospects for biological control of *Ambrosia artemisiifolia* in Europe: learning from the past. *Weed Research*, *6*, 559–573.

Gerdzhikova, M. (2014). Influence of N fertilization and predecessors on Triticale yield structure characteristics. *Turkish Journal of Agricultural and Natural Science*, *2*, 1922–1932.

Hamada, S.H.E., Abdel-Lateef, M.F., Abdelmonem, A.E., El-Kholy, R.M.A., Helalia, A.A.R. (2013). Efficiency of certain clodinafop-propargyl formulations in controlling annual grassy weeds in wheat. *Annals of Agricultural Science*, *58*(1), 13–18.

Hossard, L., Philibert, A., Bertrand, M., Colnenne-David, C., Debaeke, P., Munier-Jolain, N., Jeuffroy, M. H., Richard G., Makowski D. (2014). Effects of halving pesticide use on wheat production. *Sci Rep.*, *4*, 4405.

José-Maria, L. Sans, F.X. (2011). Weed seedbanks in arable fields: effects of management practices and surrounding landscape. *Weed Research*, *51*(6), 631–640.

Hossein, M., Ismail, B.S., (2018). Effect of Herbicides on the Density of Broad Leaf Weeds and their Effect on the Growth and Yield Components of Wheat (*Triticum aestivum* L.). *Journal of Agronomy*, *17*, 11–17.

Khan, N, Hassan, G, Khan, M.A., Khan, I. (2003). Efficacy of different herbicides for controlling weeds in wheat crop at different times of application-I. *Asian J Plant Sci*., 2, 305–309.

Kharytonov, M.M., Pashova, V.T., Bagorka, M.O., Kozechko, V.I., Dudar, T.O. (2016). Arable lands degradation in the northern steppe zone of Ukraine. *Agriculture and Forestry Journal, 62*(2), 071–080.

Modhej, A. Kaihani, A. (2013). Effect of nitrogen fertilizer and herbicides on weed control and wheat grain yield under subtropical conditions. International *Journal of Biosciences*, *3*(10), 73–81.

Pacanoski, Z., Mehmeti, A. (2018). Post herbicide programme for effective weed control in winter wheat (*Triticum aestivum* L.). *Agronomy Research, 16*(4), 1796–1808.

Shaner, D.L., Beckie, H.J. (2014), The future for weed control and technology. *Pest Management Science, 70*, 1329–1339.

Song, N.H, Yin, X.L, Chen, G.F, Yang, H. (2007). Biological responses of wheat (*Triticum aestivum*) plants to the herbicide chlorotoluron in soils. *Chemosphere*, 68, 1779–1787.

Stagnari, F., Maggio, A., Galieni, A., Pisante, M.(2017). Multiple benefits of legumes for agriculture sustainability: an overview. *Chemical and biological Technologies in Agriculture, 4*(2).

Tkalich, Yu.I., Tsyliuryk, A.I., Masliiov, S.V., Kozechko, V.I. (2018). Interactive effect of tank-mixed post emergent herbicides and plant growth regulators on corn yield. *Ukrainian Journal of Ecology*, *8*(1), 961–965.

Toigildinv, A.V., Morozov, V.I., Podsevalov, I.I., Isaev, M.Y., Toigildina, I.A. (2016). Selection of winter wheat predecessors in crop rotations of the Volga region forest steppe. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, *7*(6), 2203–2209.

Tsyliuryk, A.I., Tkalich, Yu.I., Masliiov, S.V., Kozechko, V.I. (2017). Impact of mulch tillage and fertilization on growth and development of winter wheat plants in clean fallow in Northern Steppe of Ukraine. *Ukrainian Journal of Ecology*, *7*(4), 511–516.

Varshney, S., Hayat, S., Alyemeni, M.N., Ahmad, A.. (2012). Effects of herbicide applications in wheat fields. *Plant Signal Behav*., *7*(5), 570–575.

Yin, XL, Jiang, L, Song, NH, Yang, H. (2008). Toxic reactivity of wheat (*Triticum aestivum)* plants to herbicide isoproturon. *J Agric Food Chem*., *56*, 4825–4831.