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Biological effectiveness of herbicides in winter wheat crops of autumn sowing

Abstract. An effective measure for controlling the most harmful wintering and winter weed species, such as Apera spica-venti, Galium aparine, Veronica persica, Consolida regalis, Capsella bursa-pastoris, Descurainia Sophia, Vicia villosa, etc. in winter wheat crops is the autumn application of herbicides, especially in the early stages of crop development, starting from the seed germination stage, when it is most sensitive to their presence. The study presents the results of two-year studies on the biological effectiveness of applying the herbicide Pledge 50, WP in different stages of development of winter wheat (BBCH 00, 11, 12, 14, and 16) independently and in a mixture with herbicides partners: Zenkor Liquid 600, SC, Marathon, SC, Granstar Gold 75, WG, Grodil Maxi 375, OD, and adjuvant Skaba, EC. As a result, it is identified that the biological effectiveness of the drugs under study against Apera spica-venti and other winter and wintering weeds substantially differed depending on the phase of development of winter wheat during the period of herbicide application. Pre-emergence application of herbicides does not ensure proper control of Apera spica-venti and other winter and wintering weeds. In particular, during the spring resumption of vegetation, the control of Apera spica-venti with the use of 0.1 kg/ha Pledge 50, WP was 69.0%, with an overall efficiency of 68.0%. Application of 0.4 l/ha Sencor Liquid 600, CS provided indicators of 66.1 and 71.4%, respectively. The introduction of 0.1 kg/ha of Pledge 50, WP in the BBCH 11 development phase provided high efficiency in controlling Apera spica-venti and all weeds in general with indicators of 91.2 and 87.6%, respectively. The use of a reduced rate of 0.08 kg/ha Pledge 50, WP in the BBCH 12 phase did not reduce both the overall

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effectiveness against weeds – 87.4%, and Apera spica-venti in particular – 93.1%. The use of Pledge 50, WP (0.1 kg/ha) in the BBCH 16 phase had a worse, but acceptable effect with efficiency indicators of 84.2% against Apera spica-venti and 83.6% overall. The best control of Apera spica-venti and all weeds, in general, was obtained by using a mixture of Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, EC (0.06 kg/ha + 0.025 l/ha + 0.05 l/ha) in the BBCH 14 phase – 97.5 and 99.2%, which is at the level of Sencor Liquid 600, SC + Grodil Maxi 375, OD (0.35 l/ha + 0.11 kg/ha). The highest yield of winter wheat in the experiment was obtained by applying a mixture of Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, EC (0.06 kg/ha + 0.025 l/ha + 0.05 l/ha) in the BBCH 14 phase – 7.56 t/ha, which is 59.8% better than the control

Keywords: winter wheat; herbicides; biological efficiency; Apera spica-venti; Galium Aparine; Veronica persica; Consolida regalis; Capsella bursa-pastoris; Descurainia Sophia; Vicia villosa; yield

RELEVANCE

As is known, the main and most harmful weeds in winter grain crops are winter and wintering species, such as: common windgrass (Apera spica-venti), cleavers (Galium Aparine), bird-eye speedwell (Veronica persica), field larkspur (Consolida regalis), shepherd's purse (Capsella bursa-pastoris), flixweed (Descurainia Sophia), winter vetch (Vicia villosa) *et al.* These weeds are a serious competitor to the crop for moisture and light, reduce the effectiveness of fertilisers applied. Therefore, an effective method of controlling wintering and winter weeds in winter wheat crops can be the autumn application of herbicides, especially in the early stages of crop development, starting from the stage of seed germination, when it is most sensitive to their presence.

ANALYSIS OF RECENT STUDIES AND PAPERS

According to Soltani *et al.* (2006), the constant expansion of the area under no-till and the injudicious use of glyphosate group herbicides in predecessor crops led to an increase in the presence of winter annual, biennial, and perennial weeds in winter wheat agrocenoses. According to Curran *et al.* (2017), winter wheat yields declined with increasing biomass of weeds such as winter vetch. Therefore, the autumn post-emergence application of herbicides was a priority to reduce competition with this weed during the autumn and early spring growing seasons. Therewith, the most effective and safe active ingredients for the culture were 2,4-D amine salt, mesosulfuron-methyl, tribenuron-methyl, and tifensulfuron-methyl. According to Storchous I.M. (2019), the optimal time for the use of herbicides in the autumn period in winter wheat crops is the phenological phase of crop development of 1-2 leaves, while the use of a mixture of active substances tribenuronmethyl, 562.5 g/kg and tifensulfuron-methyl, 187.5 g/kg provided one hundred per cent effectiveness against weeds. Studies by Kochyk G. and Melnychuk A. (2013) proved an increase in the yield of winter wheat by 20.1% with the autumn application of a combination of tribenuron-methyl and metsulfuron-methyl in contrast to spring.

Many studies confirm the high harmfulness of common windgrass in winter grain crops, especially in cases where their share in the structure of sown areas was more than 60%. Researcher Bartels (2004) indicates a loss of 3 t/ha of winter wheat grain yield in areas where the number of Apera spica-venti averaged 200 pcs./m^2 compared to the areas where this weed was controlled. Danish researchers Andreasen & Stryhn (2008) and Melander *et al.* (2008) also indicate an increase in the proportion of broom infestation of winter crops. Apera spica-venti ranked fifth in the ranking of the 15 most important weed species identified in 26 European countries in winter grain crops (Schroeder *et al.*, 1993). Latvian researchers identified that in winter wheat fields, where Apera spica-venti was the dominant weed with a share of 70-80% of the total weed biomass, the spring application of herbicides did not ensure proper control of this weed. Autumn post-emergence application of crop protection products resulted in satisfactory control over Apera spica-venti up to the harvest time of the next year (Vanaga *et al.*, 2010).

There are also no unambiguous results regarding the effectiveness of the pre-emergence application of herbicides in winter wheat crops. According to Streit *et al.* (2003), the effectiveness of weed control with insurance herbicides was generally better than the effectiveness of the pre-emergence application of the protective products, regardless of the intensity of tillage. However, Johnson *et al.* (2018) indicate that the effective control of grass weeds, in particular, Bromus spp. and the highest yield of winter wheat is due to the pre-emergence use of herbicides based on piroxasulfone in combination with flumioxazine.

Purpose of the study. Establish the biological effectiveness of herbicides against cereal and dicotyledonous annual winter and wintering weeds in winter wheat crops with pre-emergence and post-emergence application during the various phases of crop development.

MATERIALS AND METHODS

The study was conducted during 2018-2021 in the conditions of the Separated subdivision of the National University of Life and Environmental Sciences of Ukraine "Agronomic Research Station", Pshenychne village, Vasylkivsky district, Kyiv region, according to the scheme shown in Table 1.

Table 1. Scheme of the experiment on the examination of the biological effectiveness of herbicides

No.	Experiment options	Active ingredient	Drug consumption rates l/ha, kg/ha	BBCH
1	Control		-	-
2	Pledge 50, WP	flumioxazine, 511 g/kg	0.08	00
3	Sencor Liquid 600, SC	metribuzin (250 g/l)	0.40	
4	Pledge 50, WP	flumioxazine, 511 g/kg	0.08	12
5	Marathon, SC	pendimethalin, 250 g/l, isoproturon, 125 g/l	4.00	
6	Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, EC	flumioxazine, 511 g/kg + tribenuron-methyl, 562.5 g/kg, tifensulfuron-methyl, 187.5 g/kg + polyalkylene oxide modified with heptamethyltrisiloxane, 21%, and a complex of nonionic surfactants 79%	0.06 + 0.025 + 0.05	14
7	Sencor Liquid 600, SC + Grodil Maxi 375, OD	metribuzin, 600 g/l + iodosulfuron, 25 g/l, amidosulfuron, 100 g/l, mefenpir-diethyl (antidote), 250 g/l	0.35 + 0.11	
8	Granstar Gold 75, WG + adjuvant Skaba, EC	tribenuron-methyl, 562.5 g/kg, tifensulfuron-methyl, 187.5 g/kg + polyalkylene oxide modified heptamethyltrisiloxane, 21%, and a complex of nonionic surfactants 79%	0.025 + 0.05	
9	Pledge 50, WP	flumioxazine, 511 g/kg	0.1	11
10	Pledge 50, WP	flumioxazine, 511 g/kg	0.1	16

Experiment area is 1200 m². The area of each experiment variant is 120 m² (4 repetitions of 30 m² each). The working fluid flow rate is 300 l/ha. The placement of variants and repetitions in the experiment is randomised. The method of applying herbicides is spraying with a Jacto pjb-16C satchel sprayer. The ground cover at the station is typical medium-loamy chernozem. The humus content in the arable soil layer is 4.38-4.53%, the pH of the salt extract is 6.9-7.3; the absorption capacity is 32 mg-eq./100 g of soil. The humus Reserve in the meter thickness is 404-448 t/ha. Such soil declination is typical for the forest-steppe zone, covering 54.6% of its territory. Groundwater is at a depth of 5-6 m.

The total moisture capacity of the soil of the experimental field in the 0-30 cm layer is 38.4%, in the 30-45 cm layer – 42.75%. The field moisture capacity of this soil in a layer of 0-30 cm reaches 28.2%, capillary rupture humidity – 19.7%, maximum hygroscopicity – 7.46%, moisture inaccessible to plants – 10%, total porosity at equilibrium – 52-55%.

In the experiment, the winter wheat variety Linus was sown. The seeding rate is 3.8 million seeds/ha, seeding depth is 4 cm, row spacing width – 19 cm, predecessor – peas.

Agricultural techniques for growing winter wheat in the experiment are generally accepted for the conditions of the Right-Bank Forest-Steppe of Ukraine. Protection against pests and diseases is the same for all areas of the experiment.

Visual evaluation of the effectiveness of the drugs was determined on days 7, 14, and 28 after treatment and in the spring after the resumption of vegetation. Species composition of weeds on control and experimental options: before treatment (except for the use of pre-emergence), on the 7th, 14th, and 28th day after treatment and in the spring after the resumption of vegetation.

Determination of the biological effectiveness of herbicides was conducted according to the method of Tribel S.O. *et al.* (2001). Research methods: observation, analysis, and synthesis in combination with special methods (field, quantitative-weight, mathematical-statistical). Statistical analysis of experimental data – using Excel software from MS Office 365 and Statistica 10.

RESULTS

Visual assessment of the effect of the protective products under study was performed separately for each type of weed. In variants with the post-emergence application of drugs, the first record of the number of weeds was conducted immediately before their use. During the period of these records, 6 main types of winter and wintering weeds were present in winter wheat crops. The number of weeds in the control and experimental variants substantially differed depending on the period of application of the drugs. Apera spica-venti was the dominant species in winter wheat crops among cereal weeds. Dicotyledonous weeds were represented by five species with approximately equal numbers of each (Table 2). The first records of weeds in variants with pre-emergence use of herbicides were conducted 7 days after their application.

Table 2. Species composition and number of weeds in variants with the post-emergence application of herbicides before their application, pcs./m²

Experiment variant	Types of weeds						
	Apera spica-venti	Galium aparine	Veronica persica	Consolida regalis	Capsella bursa-pastoris	Descurainia Sophia	Total
BBCH 11							
Control	6.25	4.75	5.5	3.75	4.75	4.25	29.3
9. Pledge 50, WP	4.75	5.25	5.75	5.25	5.25	3.75	30

Table 2. Continued

Experiment variant	Types of weeds						
	Apera spica-venti	Galium aparine	Veronica persica	Consolida regalis	Capsella bursa-pastoris	Descurainia Sophia	Total
BBCH 12							
Control	13.25	4.75	8	5.5	6	6.25	43.8
4. Pledge 50, WP	13.5	6.5	6.75	7.25	6.75	5.0	45.8
5. Marathon, SC	9.25	6	7	5.25	6.5	5.0	39.0
BBCH 14							
Control	13.25	4.75	8	5.5	6	4.25	41.8
6. Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, EC	12.25	6.75	5.75	6.25	5.75	5	41.8
7. Sencor Liquid 600, SC + Grodil Maxi 375, OD	14.75	7.75	4.5	5.75	4.75	5.75	43.8
8. Granstar Gold 75, WG + adjuvant Skaba, ke	10.75	8.75	7.75	6	6.5	4.5	44.8
BBCH 16							
Control	13.25	7.5	8.5	8	12.5	6.0	55.8
10. Pledge 50, WP	10.25	8.25	5.25	5.5	6	5.8	41.0

The biological effectiveness of the drugs under study expressed in % for each type of weed was calculated to assess the effectiveness of the drugs under study. The biological effectiveness of the preparations for pre-emergence application was in the range of 57.0% against common windgrass and 58.5% in general against all types of weeds for the application of Pledge 50, WP (0.08 kg/ha) and, respectively, 52.6 and 57.0% for the use of Sencor Liquid 600, CS (0.4 l/ha). Such indicators are insufficient and are caused by unfavourable conditions that have developed during the period of their application (low soil moisture).

The introduction of Pledge 50, WP after germination of the crop in different phases of development showed high efficiency in controlling Apera spica-venti and other winter and wintering weeds. The introduction of this herbicide at a rate of 0.1 kg/ha in the development phase of winter wheat BBCH 11 provided reliable control of Apera spica-venti at the level of 93.7%, with an overall efficiency of 88.1%. Reduction of the norm of Pledge 50, WP to 0.08 kg/ha in the BBCH 12 phase of crop development, efficiency decreased by 3.5 percentage points to 90.2% against Apera spica-venti and to 86.2% overall (Table 3).

Table 3. Biological effectiveness of herbicides, %

Option No.	Types of weeds													
	Apera spica-venti		Galium aparine		Veronica persica		Consolida regalis		Capsella bursa-pastoris		Descurainia Sophia		Total	
	a	s	a	s	a	s	a	s	a	s	a	s	a	s
BBCH 00														
2.	57.0	69.0	36.3	53.5	67.9	67.1	57.3	64.3	54.2	75.7	78.5	78.5	58.5	68.0
3.	52.6	66.1	44.2	41.8	63.8	75.4	51.0	79.1	42.7	78.3	87.7	87.7	57.0	71.4
BBCH 11														
9.	93.7	91.2	80.4	74.7	83.8	84.8	95.4	90.3	82.8	91.9	92.5	92.5	88.1	87.6
BBCH 12														
4.	90.2	93.1	85.8	80.6	83.7	84.0	86.0	89.3	88.0	88.5	83.8	88.8	86.2	87.4
5.	94.5	89.3	72.8	68.8	63.4	59.9	93.3	92.6	90.1	90.3	91.4	95.0	84.3	82.7
BBCH 14														
6.	97.5	97.5	100.0	100.0	91.9	100.0	97.9	97.9	100.0	100.0	100.0	100.0	97.9	99.2
7.	96.9	94.6	98.3	94.9	73.5	75.6	100.0	100.0	96.4	96.1	100.0	100.0	94.2	93.5
8.	73.1	77.7	90.3	82.3	93.0	92.9	81.4	82.9	100.0	100.0	92.5	92.5	88.4	88.1
BBCH 16														
10.	70.5	84.2	82.3	78.5	84.5	97.0	81.6	83.9	89.6	79.4	78.7	78.7	81.2	83.6
HIP_{05}	**12.2**	**9.9**	**16.9**	**21.2**	**23.0**	**24.6**	**15.8**	**14.3**	**17.4**	**9.4**	**16.9**	**10.3**	**7.1**	**7.5**

Note: a – accounting in autumn 28 days after the introduction of herbicides, s – accounting for the period of spring restoration of vegetation of the crop

The highest efficiency of control of Apera spica-venti and other weeds in the experiment was recorded for the introduction of a mixture of Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, EC (0.06 kg/ha + 0.025 l/ha + 0.05 l/ha) – 97.5 and 97.9% in the BBCH 14 phase, which is reliable at the level of the Sencor Liquid 600, SC + Grodil Maxi 375, OD (0.35 l/ha + 0.11 kg/ha) – 96.4 and 94.2% composition. The use in the same phase of only Granstar Gold 75, WG + adjuvant Scaba, EC (0.025 kg/ha + 0.05 l/ha) provided mediocre effectiveness against Apera spica-venti – 73.1% against the background of sufficient control of dicotyledonous weeds. Notably, the Sencor Liquid 600, SC + Grodil Maxi 375, OD (0.35 l/ha + 0.11 kg/ha) composition provided insufficient control of Veronica persica – 73.5% (Table 3).

The introduction of 0.1 kg/ha Pledge 50, WP in the BBCH 16 phase provided control of Apera spica-venti with an efficiency of 70.5% and other weeds – 81.2%, which in general did not substantially differ from Granstar Gold 75, WG + adjuvant Scaba, EC (0.025 kg/ha + 0.05 l/ha).

One of the best in control of Apera spica-venti was the option with the introduction of the BBCH 12 marathon phase, SC at a rate of 4.0 l/ha – 94.5%, however, it did not provide reliable control of Veronica persica – only 63.4%, which is the lowest indicator in the experiment.

The last accounting conducted for the period of spring vegetation restoration (SVR) of winter wheat did not show substantial changes in the species composition and number of weeds in the cultivated areas. The biological effectiveness of the preparations for the spring renewal of winter wheat vegetation was higher compared to the last autumn records, which is mainly due to an increase in the number of weeds in the areas of the control variant and a decrease in their number in some herbicidal variants.

The effectiveness of soil herbicides against Apera spica-venti was 69.0% of the application of 0.08 kg/ha Pledge 50, WP and 68.0% in general against winter and wintering weeds, which is at the level of 0.4 l/ha Sencor Liquid 600, SC (Table 3).

Statistically, the same effectiveness against Apera spica-venti and other weed species was provided by the use of Pledge 50, WP (0.1 kg/ha) in the BBCH 11 phase – 91.2 and 87.6% and Pledge 50, WP (0.08 kg/ha) in the BBCH 12 phase – 93.1 and 87.4%.

The highest efficiency against these weeds was when using a mixture of Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, ke (0.06 kg/ha + 0.025 l/ha + 0.05 l/ha) in the BBCH 14 phase – 97.5 and 99.2%, which is at the level of Granstar Gold 75, WG + adjuvant Skaba, EC + Grodil Maxi 375, OD (0.35 l/ha + 0.11 kg/ha).

The use of Pledge 50, WP (0.1 kg/ha) in the BBCH 16 phase had a worse, but acceptable effect in controlling broom and other weeds in general – 84.2 and 83.6% compared to the use of this herbicide in earlier phases of winter wheat development (Table 3).

The crop yield in the control variant averaged 4.73 t/ha. All herbicidal variants had substantially higher yields, which is confirmed by dispersion analysis. The introduction of soil preparations in the second and third variants provided an increase in yield by 36.8% relative to the control over the use of Pledge 50, WP (0.1 kg/ha), which is at the level of Sencor Liquid 600, CS (0.4 l/ha) – 34.2% (Table 4).

Table 4. Winter wheat yield depending on the herbicide protection options under study

Experiment variant	Yield, t/ha	+/- to control, %
1. Control	4.73	
BBCH 00		
2. Pledge 50, WP	6.48	36.8
3. Sencor Liquid 600, SC	6.35	34.2
BBCH 11		
9. Pledge 50, WP	7.31	54.5
BBCH 12		
4. Pledge 50, WP	7.03	48.5
5. Marathon, SC	7.14	50.8
BBCH 14		
6. Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, EC	7.56	59.8
7. Sencor Liquid 600, SC + Grodil Maxi 375, OD	7.43	56.9
8. Granstar Gold 75, WG + adjuvant Skaba, ke	7.1	50.1
BBCH 16		
10. Pledge 50, WP	6.96	47.1
HIP_{05}	0.21	3.1

Applying 0.1 kg/ha of Pledge 50, WP in the BBCH 11 phase provided a substantially higher yield by 54.5% than using the same drug, but 0.08 kg/ha in the BBCH 12 phase – 48.5% and 0.1 kg/ha in the BBCH 16 phase – 47.1%.

The highest yield in the experiment was formed by applying a tank mixture of Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, EC (0.06 kg/ha + 0.025 l/ha + 0.05 l/ha) in the BBCH 14 phase – 7.56 t/ha, which is 59.8% better than the control (Table 4).

CONCLUSIONS

The biological effectiveness of the drugs under study against common windgrass and other winter and wintering weeds substantially differed depending on the phase of development of winter wheat for the use of herbicides.

Pre-emergence application of herbicides does not ensure proper control of Apera spica-venti and other winter and wintering weeds. In particular, during the SVR, the control of Apera spica-venti for the use of 0.1 kg/ha Pledge 50, WP was 69.0%, with an overall efficiency of 68.0%. Application of 0.4 l/ha Sencor Liquid 600, CS provided indicators of 66.1 and 71.4%, respectively.

Application of Pledge 50, WP after germination of the crop in the development phases of winter wheat BBCH 11-12 showed high efficiency in controlling Apera spica-venti and all weeds in general with the following indicators:

- Pledge 50, WP (0.1 kg/ha) in the BBCH 11 – phase 91.2 and 87.6%;

- Pledge 50, WP (0.08 kg/ha) in the BBCH 12 phase – 93.1 and 87.4%.

The use of Pledge 50, WP (0.1 kg/ha) in the BBCH 16 phase had a worse, but acceptable effect with efficiency indicators of 84.2 and 83.6%.

The highest effectiveness against Apera spica-venti and all weeds, in general, was for the use of a mixture of Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, EC (0.06 kg/ha + 0.025 l/ha + 0.05 l/ha) in the BBCH 14 phase – 97.5 and 99.2%, which is at the level of Sencor Liquid 600, SC + Grodil Maxi 375, OD (0.35 l/ha + 0.11 kg/ha).

The highest yield of winter wheat in the experiment was obtained by applying a mixture of Pledge 50, WP + Granstar Gold 75, WG + adjuvant Skaba, EC (0.06 kg/ha + 0.025 l/ha + 0.05 l/ha) in the BBCH 14 phase – 7.56 t/ha, which is 59.8% better than the control.

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Біологічна ефективність гербіцидів у посівах пшениці озимої осіннього внесення

Анотація. Ефективним заходом контролювання найбільш шкодочинних зимуючихта озимих видів бур'янів, таких як: *Apera spica-venti*, *Galium aparine*, *Veronica persica*, *Consolida regalis*, *Capsella bursa-pastoris*, *Descurainia Sophi*a, *Vicia villosa* та ін. у посівах пшениці озимої є осіннє внесення гербіцидів, особливо на ранніх стадіях розвитку культури, починаючи від стадії проростання насіння, коли вона найбільш чутлива до їхньої присутності. У статті наведено результати дворічних досліджень щодо біологічної ефективності внесення гербіциду Пледж 50, ЗП е різні строки розвитку пшениці озимої (BBCH 00, 11, 12, 14 і 16) самостійно та в суміші з гербіцидами партнерами: Зенкор Ліквід 600, КС, Марафон, КС, Гранстар Голд 75, ВГ, Гроділ Максі 375, ОД та ад'ювантом Скаба, КЕ. У результаті встановлено, що біологічна ефективність досліджуваних препаратів проти Apera spica-venθ й інших озимих та зимуючих бур'янів суттєво відрізнялася залежно відфази розвитку пшениці озимої на період внесення гербіцидів. Досходове внесення гербіцидів не забезпечує належного контролювання *Apera spica-venti* та інших озимих і зимуючих бур'янів. Зокрема, на період весняного відновлення вегетації контроль *Apera spica-venti* за використання 0,1 кг/га Пледж 50, ЗП становив 69,0 %, за загальної ефективності 68,0 %. Внесення 0,4 л/га Зенкор Ліквід 600, КС забезпечувало показники відповідно 66,1 та 71,4 %. Внесення 0,1 кг/га Пледж 50, ЗП у фазу розвитку культури ВВСН 11 забезпечило високу ефективність контролювання *Apera spica-venti* та загалом усіх бур'янів із показниками, відповідно, 91,2 та 87,6 %. Використання зменшеної норми 0,08 кг/га Пледж 50, ЗП у фазу ВВСН 12 не знижувало як загальну ефективність проти бур'янів – 87,4 %, так і *Apera spica-venti*, зокрема – 93,1 %. Використання Пледж 50, ЗП (0,1 кг/га) у фазу ВВСН 16 мало гірший, проте прийнятний ефект із показниками ефективності 84,2 % проти *Apera spica-venti* та 83,6 % загалом. Найкращий контроль *Apera spica-venti* та загалом усіх бур'янів отримано за використання суміші Пледж 50, ЗП + Гранстар Голд 75, ВГ + ад'ювант Скаба, КЕ (0,06 кг/га + 0,025 л/га + 0,05 л/га) у фазу ВВСН 14 – 97,5 і 99,2 %, що на рівні Зенкор Ліквід 600, КС + Гроділ Максі 375, ОД (0,35 л/га + 0,11 кг/га). Достовірно найвищу урожайність пшениці озимої в досліді отримано за внесення суміші Пледж 50, ЗП + Гранстар Голд 75, ВГ + ад'ювант Скаба, КЕ (0,06 кг/га + 0,025 л/ га + 0,05 л/га) у фазу ВВСН 14 – 7,56 т/га, що на 59,8 % краще контролю

Ключові слова: пшениця озима; гербіциди; біологічна ефективність; *Apera spica-venti*; *Galium aparine*; *Veronica persica*; *Consolida regalis*; *Capsella bursapastoris*; *Descurainia Sophia*; *Vicia villosa*; урожайність