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THE EFFECTIVENESS OF HERBICIDES AGAINST *ECHINOCHLOA* SPECIES AND BOG BULRUSH (*SCIRPUS MUCRONATUS*) IN THE RICE FIELDS IN THE SOUTHERN STEPPE OF UKRAINE

The effect of thirteen herbicides, on the basis of the active substance cyhalofop in combinations, on Echinochloa species, bog bulrush (Scirpus mucronatus) and directly on the rice plants in the field in the southern Steppe of Ukraine has been studied. The studied herbicides proved to be effective in a different degree by the effect on the complex of weeds and the influence on the amount of the saved yield. A number of herbicides were highly effective against Echinochloa species and bog bulrush (Scirpus mucronatus)
Keywords: *cyhalofop, Echinochloa species, bog bulrush, rice*

Introduction. Rice is a strategically important food plant of the globe, it feeds over a half of the mankind [1]. The potential yield of rice varieties grown in Ukraine is within 5.5-6.0 t/ha. However, the average yield is usually low and averages by years 2.2-2.6 t/ha. The main constraint to obtain high yield of rice is weeds which reduce the overall yield of groats and the whole kernel as well as worsen the seed sowing quality [2]. Long-term studies of researchers revealed that at the level of the field infestation with *Echinochloa* species up to 80 units/m the yield of rice was reduced by 1.0-1.5 t/ha, and the presence of 50 units/m of bog bulrush led to 0.7 t/ha of the yield reduction [3].

Despite widespread and often a fair criticism towards the overuse of pesticides in the rice fields in connection with the environmental risk of contamination of water resources and the surrounding areas this method in its rational implementation is up to date the most economically sound. A chemical method of protecting the cultivated plants for the regulation of undesirable vegetation still remains prevailing in the plant industry [4].

It should be noted that the range of pesticides for agricultural purposes is systematically updated, and ineffective preparations are replaced by more effective. If the effectiveness level of the pesticides remains the same those that are the least hazardous to the environment are selected [5].

The negative factor is that the intensive application of chemical means for weeds control in addition to creation of environmental problems the manifestation of the resistance of some biotypes occurs which in each successive generation becomes less susceptible to the action of formerly highly effective preparations.

That leads to the need for a constant search for new herbicides that are environmentally less hazardous, but at the same time affect the weeds effectively. That is why the purpose of our research was to study the new formulations of herbicides based on the active substance cyhalofop in various combinations to identify their effectiveness against *Echinochloa* species, bog bulrush (*Scirpus mucronatus*) and their direct effect on the rice plants in the field in the southern Steppe of Ukraine.

Materials and methods. The experiments were conducted with the rice variety Ukraina in the general crop rotation field of LLC "Bessarabia Rice" of Odessa Region, Kiliya during the 2012–2013. The experimental plots were located within the field. The plot size was 25 m^2 with 4 replications. The plot were arranged by the randomization method according to the technique of a field experiment [6]. At the time of the experimental field arrangement the rice plants were at 26^{th} stage by J. Zadoks's scale [7]. The main widespread weed species were *Echinochloa crus-galli, Echinochloa macrocarpa, Echinochloa oryzoides* (across the field on average up to 123 units/m^2)

and bog bulrush (*Scirpus mucronatus*) – 3.5 units/m^2. Other weed species were found sporadically in the field. For Kiliya region they are typical weeds in the rice paddy fields.

The treatment of the plants with the herbicides was performed by a mobile knapsack sprayer ERA-10 at the stage of the complete rice plants tillering (15.06.2013). Counting the weeds was performed straight before the treatment (the initial field infestation) , and a visual assessment of the preparations selectivity was carried out by the type of damage (0 - no damage , 100% - complete loss of plants from damage) on 7^{th}, 14^{th} and 28^{th} day after the treatment. The assessment of the herbicides effectiveness was made on 7^{th}, 14^{th}, 28^{th}, 56^{th}, 70^{th} and 85^{th} day after the treatment. The assessment of the weeds development was carried out on the check variants allocating for that the record plots, each of 0.25 m^2. Looking after the rice plants meant to maintain an appropriate water regime in the paddy fields. Before applying the herbicides the water level in the paddy fields was reduced to zero, and then for two days it was gradually raised up to 10 cm. After that the water regime was maintained in accordance with the requirements of the irrigation regime of the crop.

During the rice growing season a phytotoxic effect of the preparations on the crop was observed. The degree of chlorosis on the rice plants, their growth inhibition and the degree of their growth retardation were determined. The biometric indexes of the rice plants were studied. By the results of the study the biological and economic effectiveness of the preparations were determined.

Results and discussion. The first signs of the studied herbicides effect was noted starting from the seventh day. The percentage of dead plants of *Echinochloa* species ranged from 35-50 % in the seventh, ninth, second and third variants (the reason was the lower doses of the active substances and the physiological effect of other preparations); it was up to 70-80% in the eleventh, twelfth, fourth and fifth variants (Table 1). The effectiveness of the preparations against bog bulrush (*Scirpus mucronatus*) was 2-3 times lower, and that was associated with the morphological features of the plant. The inhibition of the rice plants by 20% occurred in the seventh, eighth and ninth variants; in the thirteenth and fourth variants the inhibition was by 2%.

Table 1

The effectiveness of the herbicides against weeds in the dynamics and the degree of rice plants inhibition by the preparations

Herbicide, reference number	The day after treatment	The inhibition of the rice plants, %	Weeds, effectiveness %			
			Echinochloa crus-galli	*Echinochloa macrocarpa*	*Echinochloa oryzoides*	*Scirpus mucronatus*
1 Check variant	7	0.0	0±0.0	0±0.0	0±0.0	0±0.0
	14	0.0	0±0	0±0	0±0	0±0
	28	0.0	0	0	0	0
	56	0.0	0	0	0	0
2 CB250	7	0.0	50±1.1	47±1.6	49±1.7	31±2.3
	14	0.0	59±2.2	61±1.6	58±1.5	38±2.9
	28	0.0	45±0.6	43±1.9	42±1.5	20±0.6
	56	0.0	24±2.5	29±3.0	26±4.4	14±1.4
3CB400	7	0.0	52±1.4	51±1.5	54±1.2	24±1.2
	14	0.0	55±0.9	56±1.2	58±0.8	28±2.2
	28	0.0	41±0.9	42±1.1	39±0.7	18±1.0
	56	0.0	22±1.9	25±2.3	22±1.9	10±1.2
4 XF25 + CB400 + trend	7	2.0	71±7.8	71±7.1	69±8.0	18±7.5
	14	2.0	79±1.1	80±1.7	81±1.2	21±0.6
	28	0.0	91±0.8	89±0.6	90±0.9	32±1.1
	56	0.0	99±0.4	98±0.4	99±0.4	47±1.8
5 XF40 + CB250 + trend	7	0.0	88±0.4	88±0.8	90±1.7	5±0.0
	14	0.0	91±0.6	90±1.2	88±0.8	17±0.6
	28	0.0	98±0.5	99±0.6	97±0.6	26±0.8
	56	0.0	100±0	100±0	100±0	37±3.0
6 XF40 + CB400 + trend	7	0.0	66±0.8	65±1.3	64±2.0	16±1.2
	14	0.5	70±1.0	69±1.5	68±0.8	28±2.2
	28	0.0	96±0.4	93±1.0	95±1.4	39±1.5
	56	0.0	100±0.2	100±0.5	99±1.0	46±1.9

7 XF 25/25	7	20.0	39±2.3	38±2.1	41±1.6	31±3.1
	14	20.0	62±0.5	60±1.8	63±1.4	43±3.5
	28	0.0	83±0.7	78±3.4	82±2.7	53±3.1
	56	0.0	96±1.4	96±2.1	95±1.6	63±3.4
8 XF 25/40	7	0.0	62±1.2	60±2.3	64±1.5	15±0.0
	14	4.0	66±0.4	64±1.6	67±0.8	27±1.6
	28	0.0	87±0.5	88±0.4	85±1.6	37±2.2
	56	0.0	100±0	100±0	100±0	48±3.1
9 XF 40/25	7	0.0	52±1.7	49±1.5	50±2.3	21±2.3
	14	0.0	68±1.1	65±1.7	67±0.8	33±1.9
	28	0.0	89±0.9	86±0.7	88±0.9	42±3.6
	56	0.0	100±0.2	100±0	100±0.5	53±4.25
10 XF 40/40	7	0.0	60±2.1	59±2.9	62±1.75	24±2.3
	14	3.75	66±3.0	64±1.6	67±2.8	36±2.1
	28	0.0	83±2.3	83±1.4	82±2.0	47±2.3
	56	0.0	98±0.9	97±1.3	98±0.7	52±1.8
11 XF25 + trend	7	0.0	70±0.6	68±0.6	69±1.6	9±2.2
	14	0.0	77±1.3	74±1.1	76±1.9	20±2.5
	28	0.0	81±1.2	83±1.1	83±1.4	36±4.3
	56	0.0	100±0.2	99±0.4	100±0	49±2.3
12 XF40 + trend	7	0.0	71±1.5	71±1.4	72±2.3	13±2.5
	14	0.0	75±0.7	76±1.1	78±1.3	24±2.7
	28	0.0	86±3.0	83±2.7	85±1.1	33±1.8
	56	0.0	100±0.2	100±0	100±0.4	55±2.7
13 XF25 + CB250 + trend	7	2.0	62±2.1	61±2.0	64±2.3	16±2.4
	14	2.0	74±1.0	72±1.5	76±1.1	29±2.7
	28	0.0	91±0.9	89±2.5	89±1.1	39±2.1
	56	0.0	100±0.2	99±0.5	100±0	51±2.1
14 P40(Citadel)	7	0.0	59±1.4	58±2.0	60±2.1	13±7.2
	14	0.0	81±0.7	80±0.7	83±0.8	39±0.9
	28	0.0	100±0.2	100±0.2	100±0.2	64±1.4
	56	0.0	100±0	100±0	100±0	76±2.3

Note. In table 1 the mean value and standard error are presented.

On the 14th day the effectiveness of the preparations increased as compared with the previous counting. The exceptions were the 2nd and 3rd variants in which after 14 days a new regrowth of the weeds occurred most likely due to the lack of the active substance with the soil activity and its auxiliary substances.

In the 7th variant the inhibition of rice plants was by 20 %, in the 8th - 4% , in the 10th - 4% , in the 13th - 2% in the 4th - 2%, in the 6th - a slight inhibition of growth (0.5%). It should be noted that when we observed the effectiveness of the herbicides effect on the 7th and 14th day we found out that the rice plants on the 7th day were slightly inhibited, but on the 14th day they restored their pigment and did not differ from the normally developed plants. A slight inhibition of rice plants in the 10th and 6th variants was associated with a delay in a plant response to the preparation.

The effectiveness of most preparations against *Echinochloa* species approached the maximum value (Table 2).

The exception is the 2nd and 3rd variants that represent the preparations which active substance has no soil activity. We revealed in these variants the regrowth of the weeds which remained viable. Due to the fact the effectiveness of the mentioned preparations decreased by an average of 10%. The percentage of bog bulrush (*Scirpus mucronatus*) mortality in all the variants was approximately two times lower than that for the *Echinochloa* species (Tables 1, 2).

Thus, the effectiveness of the preparations against *Echinochloa* species in most variants reached 100 % or it approached closely that value. In the variants where the tested preparations did not have a soil activity we revealed a further regrowth of the weeds. The effectiveness of the preparations halved compared with the level recorded on the 14th day. The percentage of bog

bulrush (*Scirpus mucronatus*) mortality in all the variants reached the maximum which was about one and a half times lower than that for *Echinochloa* species and did not exceed 70-80%.

Table 2

The number of *Echinochloa* species panicles after treatment in dynamics

Preparation	Number of panicles, units/m^2		
	14^{th} day	28^{th} day	56^{th} day
1	134,3±3,1	159,9±3,0	747,0±42,7
2	3,8±0,3	18,2±1,9	256,5±6,0
3	4,6±0,15	26,2±0,18	191,7±3,3
4	0±0,0	1,1±0,08	1,6±0,1
5	0±0,0	0,6±0,08	1,3±0,1
6	0,3±0,08	1,0±0,06	1,6±0,04
7	0,2±0,1	1,8±0,1	23,3±1,4 44
8	0,1±0,04	0,9±0,1	2,0±0,1
9	0,1±0,1	0,8±0,07	1,4±0,2
10	0,1±0,03	2,9±0,13	4,1±0,19
11	0,2±0,05	0,8±0,08	1,6±0,18
12	0,1±0,0	0,9±0,02	1,7±0,1
13	0,1±0,04	0,4±0,04	0,7±0,09
14	0±0,0	0,2±0,05	0,4±0,1

Note. In table 2 the mean value and standard error are presented.

From the above data we revealed the fact that the use of the tested preparations significantly influenced on practically all the yield component indexes (Table 3). In this case there was a direct correlation between the value of these indexes and the effectiveness value of the preparations. Within the variants the fluctuation of such indexes as the plant height and ear length was found. The indexes were minimal in the 7^{th}, 9^{th}, 11^{th}, 5^{th} , 2^{nd} and 3^{rd} variants and maximal in the 14^{th} , 13^{th} and 12^{th} variants (Table 3).

The significant changes in the grain number per ear were found. Thus, in the 2^{nd}, 3^{rd} and the check variants partially sterile and completely sterile ears were visually revealed. 1000 grain weight, grain weight per plant were minimal in the variants where the tested preparations did not have the soil activity and in the variants with reduced application rates. The maximum value of these indexes were found in the 14^{th} and 6^{th} variants. When analyzing the data of the grain weight per 1 m^2 and the yield it should be taken into account the percentage of plants that were lost due to the competition with the weed plants. Due to the fact, in this case the difference in these indexes between the variants was more noticeable than that for other indexes. Thus, in the 14^{th} and 6^{th} variants these indexes were 3.5-4 times higher than in the 2^{nd}, 3^{rd} and the check variants.

The analysis of the yield data (t/ha) shows the magnitude of the economic effectiveness of the tested preparations (table 3). The lack of economic effectiveness was revealed in the 7^{th} variant. The low percentage of the yield saving was revealed in the 3^{rd} variant. The yield of the 8^{th} and 9^{th} variants was by one-third higher than that of the check variant. The yield of the 12^{th} variant was almost two times, and of the 10^{th} , 13^{th} and 5^{th} variants two or more times higher than that of the check variant. The yield of the 11^{th}, 4^{th}, 6^{th} and 14^{th} variants was three or more times higher than that of the check variant. The highest level of the yield saving compared to the check variant was revealed in the 14^{th} variants for the check preparation Citadel.

Table 3

The structure of the rice yield

Variant	Ear length, cm	Grain number per ear, units	Ear grain weight, g	30 ear weight, g	1000 grain weight, g	Number of *Echinochloa* plants per m^2	Tillering coefficient, tillers/plant	Plant height, cm	Grain weight per plant, g	Grain weight, g/m^2	Yield, t/ha
1	13,30±0,6	70,60±1,2	1,42±0,08	42,42±0,9	19,99±1,2	747,0±42,7	1,0±0,0	60,5±1,1	1,49±0,01	223,70±2,8	2,24±0,02
2	10,20±0,2	47,87±0,4	0,97±0,2	27,17±0,5	18,89±0,7	256,5±6,0	1,1±0,0	58,5±1,2	1,35±0,03	249,80±14,4	2,50±0,14
3	10,40±0,3	51,36±1,4	0,98±0,06	29,54±1,2	19,40±0,7	191,7±3,3	1,18±0,02	54,8±2,3	1,27±0,01	248,40±1,7	2,48±0,01
4	13,80±1,0	80,70±0,9	1,65±0,05	49,58±0,8	20,52±1,1	1,6±0,1	1,26±0,02	61,4±0,8	2,81±0,07	841,50±29,7	8,42±0,29
5	11,10±0,4	59,30±1,4	1,23±0,02	36,83±0,4	21,45±1,4	-	1,2±0	68,4±0,87	1,97±0,07	608,11±18,2	6,08±0,18
6	12,60±0,4	68,40±0,8	1,41±0,04	42,39±0,2	20,80±0,7	-	1,28±0,02	68,3±1,1	2,57±0,02	817,30±16,5	8,17±0,16
7	12,10±0,5	50,60±1,1	1,08±0,05	32,47±0,7	22,20±0,4	23,3±1,4	1,0±0,02	34,2±1,1	1,41±0,04	225,60±1,5	2,26±0,01
8	14,20±0,8	51,10±0,9	1,16±0,03	34,94±0,4	23,00±1,1	-	1,05±0,02	47,8±1,1	1,50±0,02	299,28±13,7	2,99±0,13
9	12,20±0,3	56,70±2,4	1,21±0,03	36,17±0,28	21,70±0,7	-	1,08±0,02	46,3±3,5	1,65±0,02	308,10±11,3	3,08±0,11
10	14,10±1,3	72,30±1,1	1,50±0,05	45,86±0,6	22,14±0,6	3,8±0,3	1,15±0,02	55,4±1,3	2,24±0,02	651,84±16,3	6,52±0,16
11	12,10±0,3	73,70±0,7	1,46±0,05	43,90±0,7	20,03±0,8	-	1,1±0,0	60,3±1,4	2,28±0,01	710,60±8,1	7,11±0,08
12	13,40±0,8	69,10±1,1	1,32±0,05	39,47±0,5	19,80±0,9	-	1,18±0,02	64±0,7	1,91±0,08	401,90±14,2	4,02±0,14
13	12,90±0,7	59,30±0,6	1,29±0,03	38,57±0,7	22,22±0,9	-	1,2±0,0	65,4±0,6	2,12±0,09	640,67±20,7	6,41±0,2
14	13,10±0,3	76,57±1,1	1,57±0,05	47,05±0,2	20,32±0,5	-	1,3±0,0	69,4±0,8	2,84±0,02	880,90±9,6	8,86±0,09

Note. In table 3 the mean value and standard error are presented.

Conclusions. The combinations of the active substances which were involved in the experiment in a greater or lesser extent can be regarded as an effective means against *Echinochloa* weed group in the 11th, 12th, 4th, 5th and 6th variants . By the preparation effectiveness against bog bulrush (*Scirpus mucronatus*) the best were the 7th, 9th and 13th variants, but the yield in the 7th variant was the poorest.

By the effect duration, the total effect on the weed complex, the amount of saved yield in the first place, except Citadel, the eleventh, fourth, sixth, fifth and twelfth variants were notable. The preparations of the second and third variants in spite of the fact that in the early stages they demonstrated a certain degree of effectiveness after 14 days their effectiveness was practically reduced up to zero, and the cause of that could be the lack of the active substance with the soil activity.

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Аннотація

Бабаянц О. В., Неплій Л. В.

Ефективність гербіцидів проти різновидів плоскухи (Echinochloa) та очерету гострокінцевого (Scirpus mucronatus) у посівах рису у південному Степу України

Вивчено дію тринадцяти гербіцидів на основі діючої речовини цигалофоп у посівах рису на різновиди плоскух Echinochloa, очерету гострокінцевого (Scirpus mucronatus) і безпосередньо культуру рису в південному Степу України. Виділені гербіциди виявилися ефективними за сумарною дією на комплекс бур'янів та кількістю збереженого врожаю. Встановлено гербіциди високоефективні проти різновидів плоскух Echinochloa; очерету гострокінцевого (Scirpus mucronatus).

Ключові слова: *цигалофоп, плоскухи, очерет гострокінцевий, рис*

Аннотация

Бабаянц О. В., Неплий Л.В.

Эффективность гербицидов против разновидностей ежовниковых (Echinochloa) и камыша остроконечного (Scirpus mucronatus) в посевах риса в южной Степи Украины

Изучено действие тринадцати гербицидов на основе действующего вещества цигалофоп в посевах риса на разновидности ежовниковых Echinochloa, камыша

остроконечного (Scirpus mucronatus) и непосредственно культуру риса в южной Степи Украины. Выделенные гербициды оказались эффективными по суммарному действию на комплекс сорняков и количеству сохраненного урожая. Установленные гербициды высокоэффективны против разновидностей ежовниковых Echinochloa; камыша остроконечного (Scirpus mucronatus).

Ключевые слова: *цигалофоп, ежовниковые, камыш остроконечный, рис*