EFFECTIVENESS OF CHEMICAL PROTECTION AGAINST WEEDS APPLIED TO POPPY (*PAPAVER SOMNIFERUM* L.)

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Received: July 22, 2008
Accepted: May 22, 2009

Abstract: The aim of the presented studies was to determine the effect of chemical weed control on the development and yield of native poppy cultivars. The results of presented experiment showed that the native poppy cultivars are more susceptible to herbicides than 'Opal' and 'Lazur' cultivars. The yield of 'Michałko' cultivar in all treatments of chemical protection was very low. It was proved that the suggestion of a necessary protection of 'Mieszko' cultivar against weeds with lower doses of herbicides than the doses applied in the cultures of cultivars with a high content of morphine is justified. 'Mieszko' cultivar gave the highest yield on plots protected after sowing with Lentipur Flo™ 500 SC (a.s. chlorotoluron) in the dose of 1.2 l/ha and in the growth stage of 4 leaves, when the treatment was carried out with Callisto™ 100 SC (a.s. mesotrione) in the dose of 0.4 l/ha. Positive results of weed control after the application of these herbicides indicate the possibility to initiate studies aiming at authorization to use these herbicides in growing of the native cultivars of poppy (minor crop).

Key words: poppy cultivars, weed control, seed yield

INTRODUCTION

Poppy in the initial period of vegetation develops very slowly and therefore, it is an easy object for weeding. In Poland, a basic method of poppy plantations protection against weeds is hand weeding. The laboriousness of this agrotechnical technique limits the area of this plant cultivation. Growing on a larger acreage could be possible after introduction into the poppy production of some herbicides which can effectively control weeds. Such methods of production are common in Czech Republic (Wójtowicz 2001). Results of studies carried out both in Czech Republic (Bartoška 2002) and in Poland (Adamczewski and Kawczyński 1980; Horodyski *et al*. 1990; Jakubiak 2005; Wójtowicz and Wójtowicz 2006) showed a phytotoxic effect of herbicides on opium poppy. The sensitivity of poppy to herbicides is genetically conditioned. Polish poppy cultivars with a low content of morphine like 'Mieszko' and 'Michałko' are more sensitive to herbicides than the 'Opal' cultivar (Wójtowicz and Wójtowicz 2006) grown on a wide scale in Czech Republic (Wójtowicz 2003). Taking into consideration the mentioned conditionings in searching for an effective herbicide for protection of native poppy cultivars, the amount of a preparation used may be a key solution of this problem. In order to verify this hypothesis, field experiments were carried out with different herbicide doses applied pre- and postemergence.

MATERIALS AND METHODS

Field experiments were carried out in 2002–2006 at the Łagiewniki farm belonging to the Cooperative Plant Breading Station Strzelce (N 51° 46'E 17° 14'). On the basis of results obtained in 2002–2005 two herbicides were selected: Lentipur Flo™ 500 SC and Callisto™ 100 SC which were applied, besides mixture of pesticides Lentagran™ 45 WP (a. s. piridate) + Fusilade Forte™ 150 EC (a.i. fluazifop-p-butyl) in the experiment carried out in 2006. The selection of Lentagran™ and Fusilade™ was suggested by the papers of Wałkowski (2005) and Horodyski *et al*. (1990). Results presented by Horodyski *et al*. (1990) showed, that the addition of Fusilade Super™ to Lentagran™ 50 WP significantly decreases Lentagran fhytotoxicity to poppy plants. Wałkowski (2005) recommended a mixture Lentagran™ 45 + WP Fusilade Forte™ 150 EC instead of Fusilade Super™. The experiment was conducted in split-plot design in four replications. The first factor of the experiment was weed control treatment. The treatments were:

1. Without preemergence herbicide application. Callisto™ 100 SC applied postemergence in the dose of 1.0 l/ha.
2. Lentipur Flo™ 500 SC applied preemergence in the dose of 0.8 l/ha and Callisto™ 100 SC applied postemergence in the dose of 0.8 l/ha.
3. Lentipur Flo™ 500 SC applied preemergence in the dose of 1.0 l/ha and Callisto™ 100 SC applied postemergence in the dose of 0.6 l/ha.

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4. Lentipur Flo™ 500 SC applied preemergence in the dose of 1.2 l/ha and Callisto™ 100 SC applied postemergence in the dose of 0.4 l/ha.
5. Lentipur Flo™ 500 SC applied preemergence in the dose of 1.4 l/ha and mixture of Lentagran™ 45 WP + Fusilade Forte™ 150 EC applied postemergence in the doses of 3.0 kg/ha and 1.0 l/ha.
6. Lentipur Flo™ 500 SC applied preemergence in the dose of 1.6 l/ha and mixture of Lentagran™ 45 WP + Fusilade Forte™ 150 EC applied postemergence in the doses of 1.5 kg/ha and 0.5 l/ha.
7. Hand cultivated plots where thinning and weeding of interrows were carried out in the stage of 3–4 leaves.

Preemergence application was carried out, directly after sowing of poppy and postemergence application, in the stage of 4 performed leaves of poppy. Herbicide treatments were applied using a hand plot sprayer at a volume of 270 l/ha with flat-fan nozzle. Herbicides were applied in partly cloudy and windless days. The second factor of the experiment were cultivars of poppy. The research objects included: two cultivars of poppy with a high content of morphine (0.7–1.2%): 'Opal' and 'Lazur' and two cultivars permitted to be grown in Poland with a low content of morphine (< 0.04%): 'Mieszko' and 'Michałko'. The experiment was established on a suitable proper brown soil belonging to a good wheat complex the IIIa class. Before winter ploughing, the field was given 63 kg of P_2O_5/ha and 96 kg of K_2O/ ha. Seeds were sown on the 20th of April on plots of 7.2 m^2 area at the rate of 1 kg/ha. Nitrogen was applied 3 days after germination in the dose of 50 kg N/ha. In order to prevent fungal diseases, Amistar™ fungicide, in the dose of 0.8 l/ha was applied. Aphids were controlled with Karate™ insecticide in the dose of 0.1 l/ha. Five weeks after preemergence application of herbicides weeds were counted on 1 m^2 of each plot. Moreover weed species were recorded on untreated plots. Three weeks after postemergence application of each plot a degree of soil coverage by weeds in % was estimated using the agrophytosociological method. Before harvest plants and poppy-heads were counted on 1 m^2 of each plot. Poppy-heads were hand collected on the 11–12th of August and after drying seeds were threshed. Yield of seeds per plot was converted to kg/ha.

The obtained results were compared by the analysis of variance and significance of differences was defined on the confidence level of $p \leq 0.05$.

In 2006 the plant vegetation started after 25th of March. Long-lasting winter and heavy rainfall in first half of April made difficult cultivation and sowing in proper time. Emergence of poppy plants was observed on the 2nd May. Meteorological conditions in May and June were favourable to plant growth but high temperature and precipitation deficiency in flowering and ripening stages and 3 weeks shorter vegetation season of poppy caused the reduction of yield.

RESULTS

On the experiment plots ten species of weeds were observed: lambsquarter (*Chenopodium album* L.), black bindweed (*Polygonum convolvulus* L.), pale persicaria (*Polygonum lapathifolium* L.), redshank (*Polygonum persicaria* L.) field penny-cress (*Thlaspi arvense* L.), shepherd's-purse [*Capsella bursa-pastoris* (L.) Med.], field pansy (*Viola arvensis* Murr.), scentless mayweed (*Matricaria inodora* L.), smallflower Geranium (*Geranium pusillum* L.), alfilaree [*Erodium cicutarium* (L.) L'Herit.]. The dominant weeds were lambsquarter and black bindweed. Their participation in weed population was 60% and 20% respectively.

Table 1. Influence of preemergence application of Lentipur Flo™ 500 SC herbicide on number of weeds

Dose [l/ha]	Cultivars				
	Lazur	Opal	Mieszko	Michałko	Mean
	Number of weeds per 1m^2				
Untreated	24	24	26	26	25 a
0.8	21	21	21	21	21 b
1.0	19	17	18	18	18 c
1.2	17	18	19	18	18 c
1.4	22	21	19	20	21 b
1.6	22	23	21	22	22 b
Hand weeding	0	0	0	0	0 d
Mean	A 17.9	A 17.7	A 17.7	A 17.9	
LSD (0.05) for weed control treatment					2.02
LSD (0.05) for cultivar	not significant				
LSD (0.05) for interaction I					
LSD (0.05) for interaction II					

Means followed by the same letter are not significantly different according to Tukey's test (p = 0.05). Significance of data differences in row are expressed by capital letters. Significance of data differences in column are expressed by small letters

The number of weeds after sowing depended on the dose of the herbicide Lentipur Flo™ 500 SC (Table 1). Five weeks after the herbicide application, irrespective of the cultivar the least number of weeds was recorded on plots where the doses of 1.0 and 1.2 l/ha were applied. The other doses of Lentipur Flo™ 500 SC i.e. 0.8, 1.4 and 1.6 l/ha resulted in significantly higher number of weeds. Moreover higher doses of this herbicide, i.e. 1.4 and 1.6 l/ha exerted an unfavourable effect on the plants causing leaf chlorosis and contributed to a slower poppy development. Thereby it increased the weed competition. The highest number of weeds was observed on untreated plots. On all chemically treated plots Lentipur Flo™ 500 SC showed to be less effective in relation to the weeds: lambsquarter and black bindweed.

The postemergence application of herbicides significantly changed the weed control on plots. Observations carried out three weeks after the foliar application of herbicides showed that the degree of soil coverage by weeds on the studied plots depended on active substances, on the dose of herbicide and on susceptibility of a given cultivar to the applied herbicides (Table 2). On the plots of 'Lazur' cultivar where the herbicide Lentipur Flo™ 500 SC was applied preemargence in the doses of 0.8 and 1.2 l/ha and Callisto™ 100 SC postemargence in the doses of 0.8 and 0.4 l/ha respectively, as well as Lentipur Flo™ 500 SC applied preemargence in the dose of 1.6 l/ha and a mixture of Lentagran™ 45WP in the dose of 1.5 kg/ha + Fusilade Forte™ 150 EC in the dose of 0.5 l/ha postemargence, weed infestation was significantly lower than recorded on plots treated with Callisto™ 100 SC postemargence in the dose 1.0 l/ha. The least differentiation in weed infestation was registered on plots with Opal cultivar. The least weed infestation of plots (20%) of 'Mieszko' cultivar was recorded when Lentipur Flo™ 500 SC in the dose of 1.2 l/ha was applied preemergence and Callisto™ 100 SC in the dose of 0.4 l/ha applied postemergence. The result recorded on plots treated this way differed significantly from achieved on the plots where Callisto™ 100 SC was applied postemargence in the dose 1.0 l/ha as well as Lentipur Flo™ 500 SC was applied preemargence in the dose of 1.4 l/ha and a mixture of Lentagran™ 45WP in the dose of 3.0 kg/ha + Fusilade Forte™ 150 EC in the dose of 1.0 l/ha applied postemargence. On the plots with Michałko cultivar preemargence application of Lentipur Flo™ 500 SC in the dose of 1.4 l/ha and postemergence application of mixture of Lentagran™ 45WP in the dose of 3.0 kg/ha + Fusilade Forte™ 150 EC in the dose of 1.0 l/ha resulted in the highest weed infestation. However weed infestation recorded on plots treated this way did not differ significantly from plots where Lentipur Flo™ 500 SC in the dose of 1.6 l/ha and a mixture of Lentagran™ 45WP in the dose of 1.5 kg/ha + Fusilade Forte™ 150 EC in the dose of 0.5 l/ha as well as Lentipur Flo™ 500 SC in the dose of 1.2 l/ha and Callisto™ 100 SC in the dose of 0.4 l/ha were applied.

Irrespective of a cultivar, Callisto™ 100 SC and a mixture of the Lentagran™ 45 WP + Fusilade Forte™ 150 EC in the dose of 3.0 kg/ha and 1.0 l/ha showed a good effect of lambsquarter control, but the effect was not sufficient in case of black bindweed. On the other hand, in case of the application of lower doses of the Lentagran™ 45 WP and Fusilade Forte™ 150 EC, i.e. using the doses 1.5 kg/ha and 0.5 l/ha respectively, the lambsquarter species was not destroyed.

A significant interaction between cultivar and herbicide was observed for the number of poppy plants per area unit and poppy heads per plant (Table 3, 4). Among

Table 2. Effect of herbicides on the degree of soil coverage by weeds

Preemergence herbicides	Dose [l/ha]	Postemergence herbicides	Dose [l/kg/ha]	Cultivars				
				Lazur	Opal	Mieszko	Michałko	Mean
				degree of soil coverage by weeds in %				
Untreated		Callisto™ 100 SC	1.0	AB 54 a	B 26 a	A 62 a	AB 44 b	46 a
Lentipur Flo™ 500 SC	0.8	Callisto™ 100 SC	0.8	A 9 b	A 11 a	A 38 abc	A 41 b	25 b
Lentipur Flo™ 500 SC	1.0	Callisto™ 100 SC	0.6	A 20 ab	A 10 a	A 40 ab	A 48 b	29 ab
Lentipur Flo™ 500 SC	1.2	Callisto™ 100 SC	0.4	B 6 b	B 9 a	B 20 bc	A 54 ab	22 b
Lentipur Flo™ 500 SC	1.4	Lentagran™ 45 WP + Fusilade Forte™ 150 EC	3.0 + 1.0	B 33 ab	B 6 a	A 69 a	A 88 a	49 a
Lentipur Flo™ 500 SC	1.6	Lentagran ™ 45 WP + Fusilade Forte™ 150 EC	1.5 + 0.5	B 8 b	B 6 a	B 34 abc	A 74 ab	30 ab
Hand weeding				A 0 b	A 0 a	A 0 c	A 0 c	0 c
Mean				C 22	D 11	B 44	A 58	
LSD (0.05) for weed control treatment								20.4
LSD (0.05) for cultivar						8.4		
LSD (0.05) for interaction I						32.8		
LSD (0.05) for interaction II						38.9		

Explanations for tables from 2 to 5 – see table 1

Table 3. Plant number per 1m²

Preemergence herbicides	Dose [l/ha]	Postemergence herbicides	Dose [l/kg/ha]	Cultivars				
				Lazur	Opal	Mieszko	Michałko	Mean
Untreated		Callisto™ 100 SC	1.0	A 55.8 cd	A 59.5 ab	A 67.0 ab	A 52.8 a	58.8 ab
Lentipur Flo™ 500 SC	0.8	Callisto™ 100 SC	0.8	A 110.0 a	BC 71.8 a	AB 85.5 a	C 37.5 a	76.2 a
Lentipur Flo™ 500 SC	1.0	Callisto™ 100 SC	0.6	A 91.0 abc	A 80.3 a	A 87.8 a	B 36.5 a	73.9 ab
Lentipur Flo™ 500 SC	1.2	Callisto™ 100 SC	0.4	A 107.0 a b	A 72.8 a	A 94.8 a	C 20.8 a	73.8 ab
Lentipur Flo™ 500 SC	1.4	Lentagran™ 45 WP + Fusilade Forte™ 150 EC	3.0 + 1.0	A 64.3 bcd	A 74.3 a	A 55.3 ab	C 12.3 a	51.5 bc
Lentipur Flo™ 500 SC	1.6	Lentagran™ 45 WP + Fusilade Forte™ 150 EC	1.5 + 0.5	AB 55.3 cd	A 72.0 a	A 71.0 ab	B 26.0 a	56.1 ab
Hand weeding				A 30.0 d	A 26.8 b	A 31.5 b	A 24.3 a	28.1 c
Mean				A 73.3	A 65.3	A 70.4	B 30.0	
LSD (0.05) for weed control treatment								24.8
LSD (0.05) for cultivar				9.20				
LSD (0.05) for interaction I				35.79				
LSD (0.05) for interaction II				44.86				

Table 4. Mean and comparative values of poppy head number per plant

Preemergence herbicides	Dose [l/ha]	Postemergence herbicides	Dose [l/kg/ha]	Cultivars									
				Lazur		Opal		Mieszko		Michałko		Mean	
					[%]		[%]		[%]		[%]		[%]
Untreated		Callisto™ 100 SC	1.0	A 1.0 b	58	A 1.1 b	50	A 1.2 b	55	A 1.1 b	48	1.1 c	52
Lentipur Flo™ 500 SC	0.8	Callisto™ 100 SC	0.8	A 1.1a	65	A 1.2 b	55	A 1.1 b	50	A 1.2 b	51	1.1 c	52
Lentipur Flo™ 500 SC	1.0	Callisto™ 100 SC	0.6	A 1.1 a	65	A 1.1 b	50	A 1.1 b	50	A 1.2 b	52	1.1 c	52
Lentipur Flo™ 500 SC	1.2	Callisto™ 100 SC	0.4	A 1.1a	65	A 1.1b	50	A 1.2 b	55	A 1.4 b	61	1.2 bc	57
Lentipur Flo™ 500 SC	1.4	Lentagran™ 45 WP + Fusilade Forte™ 150 EC	3.0 + 1.0	A 1.1 a	65	A 1.1 b	50	A 1.2 b	55	A 1.6 b	68	1.2 bc	57
Lentipur Flo™ 500 SC	1.6 Lentagran™ 45 WP + Fusilade Forte™ 150 EC 1.5 + 0.5			B 1.1 a	65	AB 1.2 b	55	AB 1.5 b	68	A 1.7 ab	71	1.4 b	67
Hand weeding				B 1.7 a	100	AB 2.2 a	100	AB 2.2 a	100	A 2.3 a	100	2.1 a	100
Mean				C 1.2	69	BC 1.3	59	AB 1.4	62	A 1.5	64		
LSD (0.05) for weed control treatment												0.29	
LSD (0.05) for cultivar				0.14									
LSD (0.05) for interaction I				0.54									
LSD (0.05) for interaction II				0.60									

the cultivars studied in the experiment, the smallest differentiation of the plant number in result of the application of herbicides was shown for 'Opal' cultivar. 'Michałko' cultivar was characterized by the smallest number of plants to all herbicide treatments. The number of plants in 'Lazur' and 'Mieszko' cultivars depended in a high degree on the herbicide treatment. The greatest number of plants on area unit was recorded on plots where Lentipur Flo™ 500 SC was applied in the doses of 0.8; 1.0; 1.2 l/ha and Callisto™ 100 SC in the doses of 0.8; 0.6; 0.4 l/ha, respectively. The herbicide treatment exerted an effect on the ability of plants to produce poppy heads in all poppy cultivars evaluated in the experiment. A single poppy plant produced more poppy heads on plots weeded by hand. Significant differences referring to this feature occurred between the cultivars when no chemical treatments were applied and when after seeding, Lentipur Flo™ 500 SC was applied in the dose of 1.6 l/ha and when postemergence, a mixture of Lentagran™ 45WP in the dose of 1.5 kg/ha + Fusilade Forte™ 150 EC in the dose of 0.5 l/ha was applied.

The cultivar and herbicide interaction was also significant with regard to the yield (Table 5). The yield of cultivar 'Michałko' was very low on the plots treated with herbicides. 'Opal' cultivar reached high yields on all plots where the poppy plants were protected twice in the vegetation period, that is directly after seeding and at the stage of 4 leaves. 'Lazur' and 'Mieszko' cultivars gave the highest yields on plots protected after sowing with the Lentipur Flo™ 500 SC in the dose of 1.2 l/ha while in the stage of 4 leaves, when the Callisto™ 100 SC was used at the dose of 0.4 l/ha.

Table 5. Mean and comparative values for yield

Preemergence herbicides	Dose [l/ha]	Postemergence herbicides	Dose [l/kg/ha]	Cultivars									
				Lazur		Opal		Mieszko		Michałko		Mean	
				[kg/ha]	[%]	[kg/ha]	[%]	[kg/ha]	[%]	[kg/ha]	[%]	[kg/ha]	[%]
Untreated		Callisto™ 100 SC	1.0	A 331 c	31	A 453 c	36	A 270 b	30	A 382 b	39	359 d	34
Lentipur Flo™ 500 SC	0.8	Callisto™ 100 SC	0.8	A 672 bc	62	A 729 bc	58	B 380 b	42	B 401 b	41	545 bcd	52
Lentipur Flo™ 500 SC	1.0	Callisto™ 100 SC	0.6	AB 619 bc	57	A 782 bc	62	B 487 b	54	B 410 b	42	575 bc	54
Lentipur Flo™ 500 SC	1.2	Callisto™ 100 SC	0.4	A 801 ab	74	A 785 bc	63	AB 592 ab	65	B 357 b	36	634 b	60
Lentipur Flo™ 500 SC	1.4	Lentagran™ 45 WP + Fusilade Forte™ 150 EC	3.0 + 1.0	A 496 bc	46	A 724 bc	58	B 255 b	28	B 147 b	15	406 cd	38
Lentipur Flo™ 500 SC	1.6	Lentagran™ 45 WP + Fusilade Forte™ 150 EC	1.5 + 0.5	B 610 bc	56	A 869 b	69	BC 395 b	44	C 267 b	27	535 bcd	50
Hand weeding				AB 1083 a	100	A 1254 a	100	B 905 a	100	B 983 a	100	1056 a	100
Mean				B 659	61	A 799	64	C 469	52	C 421	43		
LSD (0.05) for weed control treatment												215.4	
LSD (0.05) for cultivar													
LSD (0.05) for interaction I													
LSD (0.05) for interaction II													

60.8

236.5

348.5

DISCUSSION

The presented data indicates that the kind and dose of herbicide and the susceptibility of a plant cultivar to the applied herbicide decide on weed control. The weed infestation of plots with 'Lazur' and 'Opal ' cultivars treated with herbicides directly after sowing and in the stage of 4 leaves was less as compared to plots sown with 'Mieszko' and 'Michałko', where the same method of weed control was applied. 'Michałko' cultivar was characterized by the smallest number of plants on area unit among all chemical treatments. Insufficient number of plants on a plot facilitated the development of weeds. The number of 'Mieszko' and 'Michałko' plants was the most limited by a mixture of Lentagran™ 45 WP in the dose of 3.0 kg/ha + Fusilade Forte™ 150 EC in the dose of 1.0 l/ha. After the application of that herbicide mixture leaf burn was observed. This mixture, recommended for agricultural practice (Wałkowski 2005) showed to be too phytotoxic in relation to poppy cultivars permitted to be grown in Poland. 'Mieszko' cultivar showed a good resistance to Callisto™ 100 SC applied postemergence in the dose of 0.4 l/ha. Moreover, plots with 'Mieszko' cultivar, where Callisto™ 100 SC was applied postemergence in the dose of 0.4 l/ha, showed the least weed infestation. It is worthy to note that this variant of protection was also effective in relation to lambsquerter. This fact is significant because, as reported by Załęcki (1987) weed infestation by lambsquarter contributes to a strong decrease of poppy yield and the results of our own studies show an insufficient effectiveness of lambsquarter control with this herbicide applied preemergence. A good effectiveness of Callisto™ 100 SC in the control of white goose-foot and the possibility of using this herbicide preemergence suggest to undertake studies on its application also directly after sowing of poppy. On the other hand, the average sensitivity of black bindweed to the applied, studied herbicides indicates that it is necessary to look for other more effective herbicides to control this weed.

All cultivars assessed in the experiment reached the highest yields on hand-weeded plots, where the poppy head number on area unit was frequently lower than on plots chemically protected. Lower poppy yields harvested from chemically treated plots were the result of the phytotoxic action of the applied herbicides. The phytotoxic effect of herbicides on poppy plants was stressed in earlier studies (Adamczewski and Kawczyński 1980; Horodyski *et al*. 1990; Bartoška 2002; Jakubiak 2005; Wójtowicz and Wójtowicz 2006). Results of the presented studies confirmed the earlier reports of Cihlář *et al.* (2003), Wójtowicz and Wójtowicz (2006) describing a differentiated reaction of cultivars to herbicides. The authors agree that among three cultivars: 'Opal', 'Lazur', 'Mieszko' grown in conditions of chemical protection, the highest yields were assured by 'Opal' cultivar, while the lowest were obtained from plots sown with 'Mieszko' cultivar. In the presented experiment, 'Opal' cultivar gave high yield on all plots on which weed control was performed pre-and postemegence. A good resistance to higher doses of herbicides makes the protection of this cultivar more effective in comparison with the remaining cultivars. 'Lazur' and 'Mieszko' cultivars showed the highest yields on plots protected after seeding with Lentipur Flo™ 500 SC in the dose of 1.2 l/ha and in the stage of 4 poppy leaves with Callisto™ 100 SC in the dose of 0.4 l/ha. The yield of 'Michałko' cultivar in all chemical treatments was very low. The presented results confirm the conclusions of earlier studies on sensitivity of poppy cultivars where it was shown that 'Opal' and 'Lazur' cultivars were superior in their resistance to unfavourable weather conditions in comparison with the cultivars 'Mieszko' and 'Michałko' (Wójtowicz 2007). An important element of poppy protection technology against weeds is the time of herbicides application. Wałkowski (2000, 2005) recommended to carry out the treatment in the stage of 4–6 leaves of the poppy plants. On the other hand, in the presented experiment, it was shown that the limitation of poppy plant protection to a single treatment of weed control in the form of foliar application is not sufficient. Weeds on those plots at treatment time of the leaves were already big enough to require for their control an increased herbicide dose and that dose was shown to be phytotoxic. It is stressed in these studies that pre- and postemegence application of herbicides is more effective than only postemegence application. This recommendation was shown to be a valuable one for the agricultural practice.

ACKNOWLEDGEMENTS

We thank Jola Zagierska for her participation in data collecting and crop husbandry.

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POLISH SUMMARY

OCENA SKUTECZNOŚCI OCHRONY CHEMICZNEJ W UPRAWIE MAKU LEKARSKIEGO (*PAPAVER SOMNIFERUM* L.)

Celem badań była ocena wpływu ochrony chemicznej na rozwój i plon rodzimych odmian maku. Wyższe dawki Lentipuru Flo™ 500 SC tj. 1,4 i 1,6 l/ha, niekorzystnie wpływały na rośliny powodując chlorozę liści. Przyczyniło się to do wolniejszego rozwoju maku, a tym samym zwiększyło konkurencyjność chwastów. Rozwój chwastów po siewie był zależny od dawki preparatu Lentipur Flo™ 500 SC. Pięć tygodni po aplikacji najmniej chwastów odnotowano na obiektach, na których zastosowano dawki 1,0 oraz 1,2 l/ha.

Zachwaszczenie obserwowane 3 tygodnie po zastosowaniu preparatów nalistnych zależało od rodzaju oraz dawki preparatu i podatności odmiany na zastosowane herbicydy. Najmniejsze zachwaszczenie obiektów (25%), na których wysiano odmianę Mieszko zaobserwowano, gdy zastosowano doglebowo Lentipur Flo™ 500 SC w dawce 1,2 l/ha, a w fazie 4 liści maku preparat Callisto™ 100 SC w dawce 0,4 l/ha. Preparat Callisto™ 100 SC oraz mieszanina preparatów Lentagran™ 45 WP + Fusilade Forte™ 150 EC w dawce 3 kg/ha i 1,0 l/ha dobrze zwalczały komosę białą, ale niewystarczająco rdest powojowy.

Wykazano istotną interakcję pomiędzy odmianą, a zastosowanymi herbicydami, dotyczącą liczby roślin maku na jednostce powierzchni. W wyniku zastosowania herbicydów najmniejsze zróżnicowanie liczby roślin odnotowano na poletkach z odmianą Opal. Natomiast odmiana Michałko charakteryzowała się najmniejszą liczbą roślin we wszystkich kombinacjach doświadczalnych.

Zastosowanie herbicydów spowodowało zmniejszenie liczby makówek wszystkich ocenianych w doświadczeniu odmian maku. Pojedyncza roślina maku wytwarzała więcej makówek na obiektach pielęgnowanych mechanicznie.

Wyniki prezentowanego doświadczenia wykazały, że odmiany Mieszko i Michałko są bardziej wrażliwe na herbicydy w porównaniu z odmianami Opal i Lazur. Odmiana Michałko plonowała bardzo nisko na wszystkich poletkach pielęgnowanych chemicznie. Dowiedziono słuszności założenia o konieczności ochrony odmiany Mieszko przed chwastami niższymi dawkami herbicydów od możliwych do zastosowania w uprawie odmian o średniej zawartości morfiny. Odmiana Mieszko najwyżej plonowała na obiektach chronionych po siewie preparatem Lentipur Flo™ 500 SC w dawce 1,2 l/ha, a w fazie 4 liści maku preparatem Callisto™ 100 SC w dawce 0,4 l/ha. Pozytywne rezultaty zwalczania chwastów w wyniku zastosowania tych preparatów wskazują na możliwość podjęcia badań zmierzających do autoryzacji tych herbicydów w uprawie rodzimych odmian maku.