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EVALUATION OF THREE HERBICIDES FOR WEED CONTROL IN *Carthamus tinctorius* L., *Helichrysum bracteatum* Willd., *Helipterum roseum* Benth. AND *Lonas annua* Vines et Druce CROPS

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Abstract. Chlorthal-dimethyl 7.5 and 11.25 kg ha^{-1} applied preemergence, propyzamide 1.0 and 1.5 kg ha^{-1} incorporated into the soil at the depth of 4–6 cm and trifluralin 0.75 and 1.0 kg ha^{-1} incorporated into the soil at the depth of 5–10 cm did not affect the fresh weight of shoots, length of main shoot nor the diameter of inflorescence of *Carthamus tinctorius*, *Helichrysum bracteatum*, *Helipterum roseum* and *Lonas annua* and controlled about 40 to 75% of weeds growing during eight weeks after seed sowing in 3-years experiment.

Key words: *Carthamus tinctorius*, *Helichrysum bracteatum*, *Helipterum roseum*, *Lonas annua*, chlorthal-dimethyl, propyzamide, trifluralin

INTRODUCTION

In recent years, in Poland the cropping area of ornamental plants cultivated for drying and then used for arrangement of dry bouquets increased rapidly and at present it amounts about 200 ha [Nowak 2000, Knaflewski 2003]. Many of these plants have small and slowly germinating seeds. Moreover they grow slowly after emergence and direct seeded they need several hand weeding. However, this group of ornamental plants has relatively small economical importance in agriculture and therefore there are only few informations about application of herbicides in their crop [Hagewoning 1994]. The results obtained by Borowy and Kwiatkowski [1993], Carpenter and Daniels [1966], Duczmal et al. [1978], Haramaki [1965] and Pindel and Grabowski [1997] show that chlorthal-dimethyl, propyzamide and trifluralin could be used for weed control in several ornamental plant crops. These herbicides and especially propyzamide and trifluralin are characterized by a considerable selectivity to species of *Asteraceae* family [Domańska 1991]. In the experiments carried out by Laskowska and Karczmarz [2001] and by Salera [1992] propyzamide and trifluralin controlled several weeds and did not injured *Lonas annua* and *Carthamus tinctorius*.

The aim of this experiment was an evaluation of chlorthal-dimethyl, propyzamide and trifluralin used for weed control in direct seeded crops of four ornamental plant species belonging to *Asteraceae* family and utilized for arrangement of dry bouquets: *Carthamus tinctorius, Helichrysum bracteatum, Helipterum roseum* and *Lonas annua.*

MATERIAL AND METHODS

The studies were carried out at Lublin – Felin Experimental Farm on loess-like soil containing 1.6% of organic matter and of 5.8 pH. Experimental field was fertilized with 17 kg P ha^{-1} and 36 kg K ha^{-1} in the autumn and with 50 kg N ha^{-1} in the spring next year. The usefulness of chlorthal-dimethyl (Dacthal 75W) applied in the doses of 7.5 and 11.25 kg ha^{-1}, propyzamide (Kerb 50W) 1.0 and 1.5 kg ha^{-1} and trifluralin (Triflurotox 250EC) 0.75 and 1.0 kg ha^{-1} for weed control in *Carthamus tinctorius* L., *Helichrysum bracteatum* Willd., *Helipterum roseum* Benth. and *Lonas annua* Vines et Druce was evaluated in the experiment. Propyzamide and trifluralin were sprayed one day before sowing and incorporated into the soil at the depth of 4–6 cm and 5–10 cm respectively. Chlorthal-dimethyl was sprayed immediately after seed sowing. The herbicides were applied using a knapsack sprayer with Tee-Jet nozzle and 400 dcm^3 of water per 1 hectare. The plot area treated with one herbicide at one dose was 1.44 m^2. On each plot four 1.2-m-long rows were made with interrow distances of 30 cm and then the seeds were seeded by hand, each species in a separate row. One row was considered as one replicate. *Carthamus tinctorius* was seeded at the rate of 280 g 100 m^{-2} and *Helichrysum bracteatum*, *Helipterum roseum* and *Lonas annua* were seeded at the rate of 140 g 100 m^{-2}. Weeds were counted by species in two 0.25×0.4 m frames placed randomly in interrow space 4 and 8 weeks after seeding and then the plots were weeded by hand. Observations of cultivated plants were taken throughout the whole growing season with the aim to find possible damages which could be attributed to the toxic effect of tested herbicides. The plants were cut at stem base in full blooming: *Helipterum roseum* at the and of July and the other species in August. The fresh weight of all plants harvested from one row was measured immediately after harvest. Then the length and the fresh weight of shoot as well as the diameter of inflorescences of 10 plants of each species were also measured. In the case of *Lonas annua,* the diameter of corymb formed from many small anthodiums was measured. The experiment was layed out in split-plot designe with four replications. The results were studied by analysis of variance and significance of differences was determined using Tukey's test at 0.05 probability level.

RESULTS

Each year there was a natural mixed infestation of annual weeds dominated by *Chenopodium album* (30%), *Echinochloa crus-galli* (22%), *Galinsoga quadriradiata* (15%) and *Capsella bursa-pastoris* (10%). Weeds belonging to the remaining 16 species made 33% of total weed population (tab. 1).

Table 1. Annual weed species growing in the experiment 4 weeks after seed sowing in dependence on the herbicide and its dose; means for the years 1998–2000

Tabela 1. Liczebność rocznych gatunków chwastów występujących w doświadczeniu 4 tygodnie po siewie nasion, w zależności od zastosowanego herbicydu i jego dawki; średnio z lat 1998–2000

Weed species Gatunek chwastu	Chlorthal-dimethyl Dimetylochlortal		Propyzamide Propyzamid		Trifluralin Trifluralina		Control Kontrola
	dose – dawka kg·ha^{-1}						
	7.5	11.25	1.0	1.5	0.75	1.0	
Amaranthus retroflexus L.	13	8	11	4	4	4	22
Anthemis arvensis L.	1	1	1	1	1	0	1
Capsella bursa-pastoris (L.) Med.	42	28	15	18	52	46	55
Chenopodium album L.	62	66	25	15	27	30	162
Echinochloa crus-galli (L.) P.B.	41	44	47	22	19	26	119
Galinsoga parviflora Cav.	5	13	12	14	15	15	9
Galinsoga quadriradiata Ruiz. et. Pav.	77	65	62	70	49	47	79
Gnaphalium uliginosum L.	0	0	0	0	0	0	1
Lamium amplexicaule L.	0	0	0	1	1	0	1
Matricaria chamomilla L.	2	2	6	5	5	6	0
Poa annua L.	9	7	1	1	1	1	7
Polygonum aviculare L.	1	2	0	1	0	0	1
Polygonum persicaria L.	15	22	0	0	1	5	21
Senecio vulgaris L.	13	12	6	6	2	8	11
Solanum nigrum L.	1	0	1	0	0	0	1
Stellaria media Vill.	23	19	6	4	5	3	31
Thlaspi arvense L.	2	2	0	1	0	1	3
Urtica urens L.	1	4	0	1	1	3	12
Veronica persica L.	2	0	4	1	0	0	2
Vicia cracca L.	0	0	0	0	0	0	1

Four weeks after seed sowing the number and the fresh weight of weeds growing on 1 m^2 on unweeded plot was 456 and 280.2 g on an average respectively (tab. 2). All tested herbicides reduced the weed infestation significantly and the differences in their efficacy were considerable but not significant (tab. 2). *Amaranthus retroflexus, Chenopodium album*, *Echinochloa crus-galli*, *Poa annua, Polygonum persicaria* and *Stellaria media* were susceptible to propyzamide and trifluralin and intermediate susceptible or tolerant to chlorthal-dimethyl (tab. 1).

Four weeks after first weeding the number of weeds growing on check plot was considerably lower and their fresh weight was slightly higher then at previous observation (tab. 3). Herbicides (except of trifluralin 0.75 kg ha^{-1}) reduced the number and the fresh weight of weeds significantly, however this time chlorthal-dimethyl controlled weeds better then the other two herbicides (tab. 3).

The herbicides did not affect the germination nor they caused other visible injury of cultivated plants. The fresh weight of all shoots harvested on one plot as well as the length and the fresh weight of one shoot of each species were also not affected by herbicides (tab. 4, 5, 6). The diameter of inflorescence was the less variable trait measured in the experiment (tab. 7).

Table 2. Number and fresh weight of weeds 4 weeks after seed sowing in dependence on the herbicide and its dose in the years 1998–2000

Tabela 2. Liczba i świeża masa chwastów po upływie 4 tygodni od siewu nasion, w zależności od zastosowanego herbicydu i jego dawki w latach 1998–2000

Herbicide, dose kg ha^{-1} Herbicyd, dawka kg·ha^{-1}	Number of weeds (no. m^{-2}) Liczba chwastów (szt.·m^{-2})				Fresh weight of weeds (g m^{-2}) Świeża masa chwastów (g·m^{-2})			
	1998	1999	2000	Mean Średnio	1998	1999	2000	Mean Średnio
Chlorthal-dimethyl 7.5 Dimetylochlortal	256	361	336	318	153.2	45.6	90.2	96.3
Chlorthal-dimethyl 11.25 Dimetylochlortal	224	311	308	281	121.1	38.9	72.8	77.6
Propyzamide 1.0 Propyzamid	206	220	168	198	109.4	25.0	104.0	79.5
Propyzamide 1.5 Propyzamid	113	224	141	159	53.3	27.6	44.5	41.8
Trifluralin 0.75 Trifluralina	89	162	283	178	90.5	10.1	29.1	43.2
Trifluralin 1.0 Trifluralina	213	121	260	198	32.6	8.7	13.1	18.1
Control Kontrola	555	483	600	546	468.1	89.2	283.2	280.2
Mean Średnio	237	269	299	268	146.9	35.0	91.0	91.0
LSD $_{0.05}$ Herbicides – Herbicydy				181.2				156.53
NIR $_{0.05}$ Years – Lata				58.5				49.36
Herbicides × years – Herbicydy × lata				342.3				258.64

Table 3. Number and fresh weight of weeds growing 8 weeks after seed sowing in dependence on the herbicide and its dose in the years 1998–2000

Tabela 3. Liczba i świeża masa chwastów rosnących po upływie 8 tygodni od siewu nasion, w zależności od herbicydu i jego dawki w latach 1998–2000

Herbicide, dose kg ha^{-1} Herbicyd, dawka kg·ha^{-1}	Number of weeds (no. m^{-2}) Liczba chwastów (szt.·m^{-2})				Fresh weight of weeds (g m^{-2}) Świeża masa chwastów (g·m^{-2})			
	1998	1999	2000	Mean Średnio	1998	1999	2000	Mean Średnio
Chlorthal-dimethyl 7.5 Dimetylochlortal	47	62	41	50	99.1	45.2	214.0	119.4
Chlorthal-dimethyl 11.25 Dimetylochlortal	41	54	37	44	102.4	31.6	161.7	98.6
Propyzamide 1.0 Propyzamid	74	80	35	63	177.2	64.8	72.2	104.7
Propyzamide 1.5 Propyzamid	95	68	31	65	228.5	54.1	47.7	110.1
Trifluralin 0.75 Trifluralina	111	79	27	72	188.6	51.0	97.5	112.4
Trifluralin 1.0 Trifluralina	86	58	25	56	104.2	37.6	85.4	75.7
Control Kontrola	162	129	69	120	387.5	121.9	382.6	297.3
Mean Średnio	88	76	38	67	183.9	58.0	151.6	131.2
LSD $_{0.05}$ Herbicides, herbicydy				53.5				134.14
NIR $_{0.05}$ Years, lata				21.7				46.63
Herbicides × years, herbicydy × lata				114.2				225.12

Table 4. Fresh weight of shoot (kg 100 m^{-2}) of *Carthamus tinctorius*, *Helichrysum bracteatum*, *Helipterum roseum* and *Lonas annua* measured immediately after harvest in dependence on herbicide and its dose

Tabela 4. Świeża masa pędów (kg·100 m^{-2}) krokosza barwierskiego, kocanki ogrodowej, suchołuski różowej i lonasa rocznego, mierzona bezpośrednio po zbiorze, w zależności od zastosowanego herbicydu i jego dawki

Herbicide, dose kg ha^{-1} Herbicyd, dawka kg·ha^{-1}	*Carthamus tinctorius*				*Helichrysum bracteatum*				*Helipterum roseum*				*Lonas annua*			
	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio
Chlorthal-dimethyl 7.5 Dimetylochlortal	621	606	414	547	658	686	554	633	586	446	414	482	478	450	366	431
Chlorthal-dimethyl 11.25 Dimetylochlortal	713	591	409	571	760	602	550	637	534	422	466	474	522	473	355	450
Propyzamide 1.0 Propyzamid	631	570	446	549	778	675	470	641	478	506	398	461	577	482	334	464
Propyzamide 1.5 Propyzamid	619	597	413	543	728	711	514	651	574	546	434	518	551	523	314	463
Trifluralin 0.75 Trifluralina	674	645	402	574	695	637	535	622	531	569	516	539	469	421	316	402
Trifluralin 1.0 Trifluralina	601	593	416	537	666	571	589	609	498	578	436	504	506	474	294	425
Control Kontrola	616	602	395	538	645	631	561	612	550	614	410	525	564	488	307	453
Mean Średnio	639	601	414	551	704	645	539	629	536	526	439	500	524	473	327	441
$LSD_{0,05}$ Herbicides – Herbicydy				n.s. – n.i.				n.s. – n.i.				n.s. – n.i.				n.s. – n.i.
$NIR_{0,05}$ Years – Lata				76.1				80.3				53.4				46.7
Herbicides × years – Herbicydy × lata				n.s. – n.i.				n.s. – n.i.				n.s. – n.i.				n.s. – n.i.

Table 5. Length (cm) of main shoot of *Carthamus tinctorius*, *Helichrysum bracteatum*, *Helipterum roseum* and *Lonas annua* measured immediately after harvest in dependence on herbicide and its dose

Tabela 5. Świeża masa (g) pędu głównego krokosza barwierskiego, kocanki ogrodowej, suchołuski różowej i lonasa rocznego, mierzona bezpośrednio po zbiorze, w zależności od zastosowanego herbicydu i jego dawki

Herbicide, dose kg ha^{-1} Herbicyd, dawka kg·ha^{-1}	*Carthamus tinctorius*				*Helichrysum bracteatum*				*Helipterum roseum*				*Lonas annua*			
	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio
Chlorthal-dimethyl 7.5 Dimetylochlortal	89	77	59	75	86	85	70	80	60	60	58	59	45	49	44	46
Chlorthal-dimethyl 11.25 Dimetylochlortal	79	83	60	74	87	83	72	81	55	58	59	57	49	45	48	47
Propyzamide 1.0 Propyzamid	83	75	58	72	83	86	74	81	61	59	60	60	54	46	47	49
Propyzamide 1.5 Propyzamid	84	74	56	71	79	81	78	79	62	54	59	58	52	43	48	48
Trifluralin 0.75 Trifluralina	78	75	58	70	88	79	78	82	61	58	60	60	53	46	48	49
Trifluralin 1.0 Trifluralina	82	69	59	70	89	85	68	81	59	57	64	60	49	48	47	48
Control Kontrola	85	81	56	74	90	86	71	82	62	63	58	61	49	48	44	47
Mean Średnio	82.9	76	58	72	86	84	73	81	60	58	60	59	50	46	47	48
$LSD_{0,05}$ Herbicides – Herbicydy				n.s. – n.i.				n.s – n.i.				n.s. – n.i.				n.s. – n.i.
$NIR_{0,05}$ Years – Lata				3.4				4.8				3.0				2.8
Herbicides × years – Herbicydy × lata				19.7				21.9				14.6				12.1

Table 6. Fresh weight (g) of shoot of *Carthamus tinctorius*, *Helichrysum bracteatum*, *Helipterum roseum* and *Lonas annua*, measured immediately after harvest in dependence on herbicide and its dose

Tabela 6. Świeża masa (g) pędu krokosza barwierskiego, kocanki ogrodowej i suchlinu różowego mierzona bezpośrednio po zbiorze, w zależności od zastosowanego herbicydu i jego dawki

Herbicide, dose kg ha^{-1} Herbicyd, dawka kg·ha^{-1}	*Carthamus tinctorius*				*Helichrysum bracteatum*				*Helipterum roseum*				*Lonas annua*			
	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio
Chlorthal-dimethyl 7.5 Dimetylochlortal	141	137	99	126	118	104	60	94	11	13	6	10	49	52	10	37.0
Chlorthal-dimethyl 11.25 Dimetylochlortal	156	134	95	128	109	94	83	95	11	10	6	9	52	45	11	36.0
Propyzamide 1.0 Propyzamid	143	131	121	132	108	116	76	100	15	14	7	12	62	46	12	40.0
Propyzamide 1.5 Propyzamid	141	132	100	124	106	88	84	93	16	10	7	11	56	40	16	37.0
Trifluralin 0.75 Trifluralina	153	140	96	130	86	109	81	92	14	13	6	11	60	43	10	38.0
Trifluralin 1.0 Trifluralina	136	132	102	123	95	89	82	89	12	12	6	10	61	44	12	39.0
Control Kontrola	138	136	91	122	103	119	70	97	15	14	5	11	58	50	11	40.0
Mean Średnio	144	135	101	126	104	103	77	94	13	12	6	11	57	46	12	38.0

$LSD_{0.05}$	Herbicides – Herbicydy	n.s. – n.i.	n.s. – n.i.	n.s. – n.i.	n.s. –n.i.
$NIR_{0.05}$	Years – Lata	24.3	19.1	2.0	9.1
	Herbicides × years – Herbicydy × lata	59.6	43.7	4.3	21.7

Table 7. Diameter (mm) of inflorescence of *Carthamus tinctorius*, *Helichrysum bracteatum* and *Helipterum roseum* and diameter of corymb of *Lonas annua** in dependence on herbicide and its dose

Tabela 7. Średnica (mm) kwiatostanu krokosza barwierskiego, kocanki ogrodowej i suchlinu różowego oraz średnica baldachogrona lonasa rocznego w zależności od zastosowanego herbicydu i jego dawki

Herbicide, dose kg ha^{-1} Herbicyd, dawka kg·ha^{-1}	*Carthamus tinctorius*				*Helichrysum bracteatum*				*Helipterum roseum*				*Lonas annua*			
	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio	1998	1999	2000	Mean średnio
Chlorthal-dimethyl 7.5 Dimetylochlortal	28	27	29	28	36	41	39	39	42	40	42	41	28	32	28	29
Chlorthal-dimethyl 11.25 Dimetylochlortal	33	26	29	29	37	38	34	36	42	43	41	42	33	29	28	30
Propyzamide 1.0 Propyzamid	33	28	34	32	35	43	33	37	43	40	42	42	29	27	29	28
Propyzamide 1.5 Propyzamid	27	30	37	31	39	36	38	38	44	41	42	42	32	28	33	31
Trifluralin 0.75 Trifluralina	32	29	29	30	38	39	35	37	43	42	43	43	29	31	30	30
Trifluralin 1.0 Trifluralina	35	28	29	31	38	37	34	36	42	40	43	42	33	28	31	31
Control Kontrola	32	28	30	30	37	42	33	37	43	41	43	42	29	31	28	29
Mean Średnio	31	28	31	30	37	39	35	37	43	41	42	42	30	29	30	30
$LSD_{0.05}$ Herbicides – Herbicydy				n.s. – n.i.				n.s. – n.i.				n.s. – n.i.				n.s. – n.i.
$NIR_{0.05}$ Years – Lata				n.s. – n.i.				3.9				n.s. – n.i.				n.s. – n.i.
Herbicides × years – Herbicydy × lata				n.s. – n.i.				9.4				n.s. – n.i.				n.s. – n.i.

* In the case of *Lonas annua*, the diameter of top umbel-shaped inflorescence was measured
W przypadku lonasa mierzono średnicę szczytowego, baldachokształtnego kwiatostanu

The weather conditions differed greatly during 3-year period of studies and this had a significant effect on the growth and much less effect on the diameter of inflorescence of cultivated plants. In few treatments the reaction of plants to herbicides differed significantly depending on the year of study (tab. 4–7).

DISCUSSION

Every year after seed sowing there was a 2–3 weeks period of drought influencing negatively the efficacy of tested herbicides. The activity of soil incorporated propyzamide and trifluralin was less depended on soil moisture [Ashton and Monaco 1991] and therefore they controlled weeds better than chlortal-dimethyl at that time (tab. 2). With the rainfalls occurring later, the herbicidal activity of chlorthal-dimethyl applied on soil surface increased more than the activity of other two compounds (tab. 3).

All tested herbicides were useful for weed control in *Carthamus tinctorius*, *Helichrysum bracteatum*, *Helipterum roseum* and *Lonas annua* crops. They were selective to cultivated plants and controlled several weed species during eight weeks after seed sowing. This agrees partly with the results obtained by Borowy and Kochanowski [2001] and Salera [1992] with regard to *Carthamus tinctorius* and by Laskowska and Karczmarz [2001] with regard to *Lonas annua*. No informations on chemical weed control in *Helichrysum bracteatum* and *Helipterum roseum* were found in the literature.

In practice, the choice of herbicide should be dependent on weed flora infesting the crop. On a field infested mainly with grass weeds and *Amaranthus retroflexus, Chenopodium album*, *Poa annua, Polygonum persicaria* and *Stellaria media,* the application of propyzamide and trifluralin would be more suitable than the application of chlorthal-dimethyl. Trifluralin will be more useful than propyzamide on fields infested heavily with *Amaranthus retroflexus* but propyzamide will be more efficiend than trifluralin on fields infested with *Capsella bursa-pastoris*. Poor weed control can be expected on fields infested with *Matricaria chamomilla*, *Galinsoga* sp. and *Senecio vulgaris* (tab. 1). Obtained results confirm the opinion of Domańska [1991] that the herbicides studied in the experiment are selective to plant species of *Asteraceae* family.

CONCLUSIONS

1. Chlorthal-dimethyl 7.5 and 11.25 kg ha^{-1} applied preemergence was selective to *Carthamus tinctorius*, *Helichrysum bracteatum*, *Helipterum roseum* and *Lonas annua* and controlled 40 to 65% of weeds during 8 weeks after seed sowing.

2. Propyzamide 1.0 and 1.5 kg ha^{-1} incorporated into the soil at the depth of 4–6 cm was selective to cultivated plants and controlled 45 to 70% of weeds growing in the experiment.

3. Trifluralin 0.75 and 1.0 kg ha^{-1} incorporated into the soil at the depth of 5–10 cm was selective to cultivated plants and controlled 40 to 65% of weeds.

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OCENA PRZYDATNOŚCI TRZECH HERBICYDÓW DO ZWALCZANIA CHWASTÓW W UPRAWIE KROKOSZA BARWIERSKIEGO (*Carthamus tinctorius* L.), KOCANEK OGRODOWYCH (*Helichrysum bracteatum* Willd.), SUCHLINU RÓŻOWEGO (*Helipterum roseum* Benth.) I LONASA ROCZNEGO (*Lonas annua* Vines et Druce)

Streszczenie. W trzyletnim doświadczeniu polowym dimetylochlortal stosowany przedwschodowo w dawkach 7,5 i 11,75 kg·ha^{-1}, propyzamid stosowany w dawkach 1,0 i 1,5 kg·ha^{-1} i mieszany z glebą na głębokość 4–6 cm oraz trifluralina stosowana w dawkach 0,75 i 1,0 kg·ha^{-1} i mieszana z glebą na głębokość 5–10 cm nie miały wpływu na świeżą masę pędów, długość pędu głównego ani na średnicę kwiatostanu kocanek ogrodowych, krokosza barwierskiego, lonasa rocznego i suchlinu różowego oraz zwalczały od około 40 do 75% występujących w doświadczeniu chwastów.

Słowa kluczowe: kocanki ogrodowe, krokosz barwierski, lonas roczny, suchlin różowy, dimetylochlortal, propyzamid, trifluralina

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