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EVALUATION OF SOME HERBICIDES AGAINST FLAX DODDER (*CUSCUTA EPILINUM* WEIHE) IN FIBRE FLAX (*LINUM USTATISSIMUM* L.) CULTIVATION

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Abstract: Two field experiments were carried out in Sakha Experimental Station during two seasons to evaluate the efficacy of different treatments (hand combing, butralin, tribenuron-methyl, metosulam and fluazifop-p-butyl) in controlling dodder weed (*Cuscuta epilinum* Weihe) in Fibre flax. Moreover, the effect of these treatments on some growth characters of flax yield and its components was also determined. All tested herbicide treatments decreased the dodder infestation in flax for up to 49 days. All tested herbicide treatments increased all flax growth characters, (straw yield and seed yield). Butralin herbicide gave the best control of dodder, followed by metosulam, tribenuron-methyl and fluazifop-p-butyl. Also, the data revealed that most herbicidal treatments slightly decreased protein content of flax plants and did not adversely affect the oil content of its seeds. This study suggests that, under heavy infestation of dodder weed, the use of the tested herbicides, especially butralin, is highly recommended.

Key words: flax dodder, Fibre flax, weed, herbicides, control

INTRODUCTION

Fibre Flax (*Linum usitatissimum* L.) is one of the well known ancient crops grown for its fiber and oil. In Egypt it is grown as a double-purpose crop; for its seed and its fiber. Fibre flax is considered the second fibre crop after cotton to play an important role in the national economy. It is one of the crops, which increases the national income and may contribute to an increase in exports.

Cuscuta spp., commonly known as dodder, are key weeds in Europe, the Middle East, Africa, North and South America (Parker and Riches 1993). *Cuscuta* spp. are obligate parasitic plants with approximately 170 different species throughout the world (Holm *et al.* 1997). All species of the genus *Cuscuta* are obligate parasites that attack stems and leaves of a wide variety of host species, including forage crops and vegetables, some tree crops (grapevine, coffee), and ornamentals. Estimates of forage crop losses range from 20 to 57%, and sugar beet yields are reduced by 3.5–4 t/ha (Aly *et al.* 2003). In Egypt, dodder is a serious problem in some fields of forage and vegetable crops, fruit trees and ornamental plants (Al-Menoufi *et al.* 1983). In recent years an increasing numbers of farmers reported troubles due to dodder (*Cuscuta* spp.) infection. Dodder affects the growth and yield of infected plants and causes losses which range from slight to complete destruction of the crop (Agrios 1978).

Cuscuta epilinum Weihe considered one of the most threatening weeds in flax crop that decreased flax technical length and fiber length, straw yield, seed yield and extracted oil indine value. *C. epilinum* increased seed moisture content, refractive index and acid value of extracted oil. However, number of flax seed/g, seed germination percentage, fiber fines, waste percentage and oil percentage were unaffected (Al-Shair 1986). Also, infection of flax with this weed leads to large losses by reducing seed yield, lowering seed quality, interfering with machine harvesting and adding to the cost of clearing seed (Dawson 1978).

Once dodder attaches to its host and is growing rapidly, it is very difficult to control without causing injury to the host. In flax it is nearly impossible to use any mechanical method for weed control. However, chemical weed control plays an important role in improving the growth of flax plants. Such an improvement consequently increase the productivity of a unit area and lowers the cost of production compared to hand weeding.

Several herbicides were tested as postemergence control for dodder in agricultural crops. Previous research showed that glyphosate at 87.5 g active substance (a.s.)/ha can selectively kill the exposed portions of dodder in alfalfa (Dawson 1990). However, some of the embedded dodder (*haustoria)* survived and the dodder regenerated. Dodder made its comeback even after all visible external dodder were destroy by the herbicide.

Therefore, effective chemical control methods for dodder weed that at the same time do not affect the growth

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characters and crop yield are in demand in Egypt. The present study was carried out to evaluate the efficacy of chemical and mechanical methods on the control of dodder weeds as well as to investigate their effects on growth characters, yield and the components of flax crop.

MATERIALS AND METHODS

Experimental design

Two field experiments were conducted at Sakha Agricultural Research Station during two successive seasons to study the effectiveness of some herbicides for controlling flax dodder (*C. epilinum*) in fibre flax crop (*L. usitatissimum*) c.v. Giza7. Sowing dates were during the third week of November in both seasons. These experiments were laid out in a randomized complete block design. Four replications were done on a plot area of 10.5 m^2. The area was artificially infested with dodder seeds, which were mixed with soil at 5% of flax seeds (w/w). In this study seven treatments were used as follows:

- Amex 48% EC (a.s. butralin) at 228.57 g a.s./ha surface application (after sowing and before irrigation)
- Granstar 75% DF (a.s. tribenuron-methyl) at 14.25 g a.s./ha, applied twenty-one days after sowing
- Sinal 10% SC (a.s. metosulam) at 9.52 g a.s./ha, applied twenty-eight days after sowing
- Fusilade Super 12.5% EC (a.s. fluazifop-p-butyl) at 297.2 g a.s./ha, applied thirty days after sowing
- hand combing (twice), carried out 45 and 60 days after sowing
- healthy plants (uninfested)
- control (infested).

Herbicides in both investigations were sprayed using a knapsack sprayer CP_3 with an application rate of 476 l/ha, a spray pressure of 1.5 bar and a Cooper Pegler Reflex nozzle. All agronomic practices in flax such as land preparation, fertilization and irrigation were done as recommended during the two study seasons. The following data were recorded.

Fresh and dry weight of dodder weed

Dodder weed was hand pulled at random from one square meter of each plot after 60 and 90 days of sowing. Afterwards, the weeds were dried in a forced draft oven at 70°C for 48 hours. The fresh and dry weight of dodder weed were estimated as kg/ha.

Flax growth characters and yield components

The growth characters of flax plants were calculated after 60 and 90 days from sowing and at harvest. Ten plants were taken at random from each plot to calculate the growth characters. While flax yield and its components were determined at harvest from plants of each plot.

Oil content

The samples of seeds were taken randomly from each treatment to determine oil content according to the method described by the A.O.A.C. (1990), using petroleum ether (40–50°C) in a soxhlet apparatus.

Crude protein content

Protein content was determined using the improved kjeldahl method according to A.O.A.C. (1980).

Chlorophyll and carotene content

Chlorophyll a, b and carotene content as mg/gm fresh weight were determined according to the method described by Sweeny and Matin (1961).

Statistical analysis

The obtained data were subjected to proper statistical analysis of variance according to the method described by Snedecor and Cochran (1980). The least significant difference (LSD) at a 5% level of significance was calculated.

RESULTS AND DISCUSSION

Effect of weed control treatment on fresh and dry weight of flax dodder

The effect of weed control treatments on fresh and dry weight of flax dodder at 21, 35 and 49 days after treatments are shown in table 1. The data revealed that the *C. epilinum* was very sensitive to the herbicide butralin at a rate of 2 28.57 g a.s./ha when used as a surface application. Hence, it was found that this herbicide mainly prevents seed germination of *C. epilinum* for forty-nine days after treatment.

The hand combing treatment was the least effective in *C. epilinum* control with percent of reduction 50.63 and 56.33% in both seasons, respectively, as compared to the control (infested) treatment. On the other hand, herbicide butralin at a rate of 228.57 g a.s./ha when used as a surface application (after sowing before irrigation), followed by metosulam at a rate of 9.52 g a.s./ha and tribenuron-methyl at a rate of 14.25 g a.s./ha were the most effective treatments used on dodder (*C. epilinum*). These herbicides recorded the highest control (90.9, 90.6 and 85.6%) in the first season and (89.7, 87.5 and 86.5%) in the second season, respectively. The fresh weight at forty-nine days after treatment gave the same results as after 21 and 35 days from application. These results are in agreement with that of Soliman (2002).

Data in table 1, revealed that all herbicides caused deleterious effects to *C. epilinum* Weihe, but the herbicides differed in the time needed to show these effects. Some of the herbicides exhibited a good effect within a short time and the other needed a long time after application to show positive effects.

It was observed that the percent of reduction data of *C. epilinum* were only slightly affected by the hand combing treatment as compared with other tested herbicides. Therefore, these results confirmed that hand combing treatment was not enough to control *C. epilinum* weeds. The results in this study agreed with the results obtained by Sher and Shad (1989) and Soliman (2002). Also, from the above results it could be concluded that the herbicides butralin, metosulam, tribenuron-methyl and fluazifop-p-butyl had strong, determined effects on *C. epilinum*.

Results showed that the herbicides caused a significant reduction in the weight of *C. epilinum* in flax after different treatment times. The results also showed that

Table 1. Effect of some control treatments on fresh and dry weight [kg/ha] of dodder weed in both tested seasons

Treatments	Rate	21 days		35 days		49 days	
	[g a.s./ha]	FW [kg/ha]	DW [kg/ha]	FW [kg/ha]	DW [kg/ha]	FW [kg/ha]	DW [kg/ha]
Season 1							
Butralin	228.57	545.7	49.8	411.9	79.3	430.3	90.6
Metosulam	14.25	679.1	51.6	411.9	87.6	445.4	116.8
Tribenuron-methyl	9.52	716.4	74.2	541.0	106.3	684.6	92.4
Fluazifop-p-butyl	297.2	1259.	139.6	1020.5	128.9	957.2	127.8
Hand combing	–	2003.5	200.0	2375.2	163.4	2341.0	161.9
Control (infested)	–	3001.4	311.1	3777.6	438.6	4741.7	520.6
Healthy plants	–	0	0	0	0	0	0
LSD 5%		514.3	17.9	479.1	92.9	458.9	101.5
Season 2							
Butralin	228.57	512	63.8	582.9	80.4	636.2	89.3
Metosulam	14.25	668	51.6	101.5	86.0	832.9	762.1
Tribenuron-methyl	9.52	799	78.0	90.2	80.2	777.3	722.4
Fluazifop-p-butyl	297.2	1904	161.8	1527.3	138.8	1594.1	134.2
Hand combing	–	2103	225.2	2169.5	220.1	2708.3	263.5
Control (infested)	–	4802	451.4	5536.7	514.2	6200.7	587.6
Healthy plants	–	0	0	0	0	0	0
LSD 5%		537.4	15.6	246.6	40.2	267.5	69.9

FW – fresh weight
DW – dry weight

herbicide (soil application) was the most effective treatments for the control of *Cuscuta* spp. Similar results were reported by Abd El-Wahed (1996) and Soliman (2002). They stated that butralin and pendimethalin which were tested as a pre-sowing application were significantly effective in reducing the infestation of *Cuscuta* spp.

Effect of weed control treatments on some growth characters of flax plants

The effect on length of flax plant

Data recorded in table 2 show the effect of weed control treatments on plant length (cm) at 60 and 90 days after sowing and at harvest day in the first and second seasons. All tested herbicides increased the plant length three times in both seasons as compared to the control (infested) treatment. The latter gave the lowest plant length of flax plant as compared to the healthy plant treatment. These results are similar with that obtained by Al-Menoufi *et al*. (1983), Al-Sahir (1986), Fesehaie (1992) and Soliman (2002). They observed that parasitic weed not only deprives the host plants of nutrients but also inhibits growth.

Data also revealed that the herbicide butralin at the rate of 228.57 g a.s./ha gave the tallest plants. Butralin increased the plant length by about 36.39 and by about 48.97 cm at harvest when used as surface application (after sowing and before irrigation) in both seasons relative to the infested control treatment. Metosulam at a rate of 9.52 g a.s./ha and tribenuron-methyl at a rate of 14.25 g a.s./ha came after butralin in regard to growth character of flax plants. While the herbicide fluazifop-p-butyl gave the lowest plant height as compared to the other herbicides.

The effect on dry weight of flax plants

Data in table 2 revealed that dry weight of flax plants at 60 and 90 days and at harvest in both seasons were significantly influenced by weed control treatments during both seasons. The herbicide butralin gave the significantly highest values. Butralin increased the dry weight of flax plants at harvest by 63.53 and 65.17% in two seasons, respectively, followed by metosulam and tribenuron-methyl relative to the infested control treatment. The herbicide fluazifop-p-butyl gave the lowest values compared with other herbicides. The hand combing treatment recorded the least dry weight of flax plants as compared to all herbicides and the uninfected control treatment. This reduction in dry weight under the infested control treatment might be attributed to the negative effect of different weeds on flax plant growth which may be occurred as a result of the competition between flax plants and weeds. The superiority of herbicide treatments might be attributed to lower weed competition as a result of eliminating weeds and their negative impact on crop plants.

The effect on fibre flax technical length of panicle

Data presented in table 2 showed significant differences for weed control treatments on technical length of panicle. All herbicides treatments were superior in increasing these traits compared to hand combing and infested control treatments in both seasons. Results, also showed that using the herbicides was necessary to eliminate fibre flax dodder and to avoid their negative impacts on flax plants. Similar results were reported by Soliman (2002). Some trend was noticed for plant length and dry weight during both seasons.

Table 2. Effect of weed control treatments on some growth characters of flax plants in both tested seasons

Treatment	Rate [l/ha]	60 days		90 days		at harvest		
		PH [cm]	DW plant [g]	PH [cm]	DW plant [g]	PH [cm]	DW plant [g]	fruit zone length [cm]
Season 1								
Butralin	228.57	48.8	0.42	79	4.16	102.75	5.1	13.75
Metosulam	14.25	46.78	0.38	77.75	3.82	99.3	4.82	11.55
Tribenuron-methyl	9.52	44.83	0.37	75.88	3.25	95.65	4.54	10.34
Fluazifop-p-butyl	297.2	43.35	0.37	73.38	3.1	87.25	3.86	9.5
Hand combing		41.56	0.31	69.88	2.86	72.64	3.18	8.3
Control (infested)		40.25	0.28	58.13	1.92	66.36	1.86	4.6
Healthy plants		53.16	0.47	82.7	4.54	11205	5.67	14.65
LSD 5%		18.0	0.3	16.2	1.2	18.4	1.7	12.8
Season 2								
Butralin	228.57	54.72	0.48	81	4.13	108.65	5.34	13.5
Metosulam	14.25	51.37	0.43	77.45	3.96	102.48	4.76	11.73
Tribenuron-methyl	9.52	47.9	0.39	74.5	3.74	99.62	4.67	10.28
Fluazifop-p-butyl	297.2	42.85	0.36	71.86	3.12	86.23	3.68	9.23
Hand combing	–	41.28	0.32	68.45	2.65	74.25	2.76	7.84
Control (infested)	–	40.12	0.31	56.7	1.89	59.68	1.86	6.35
Healthy plants	–	60.45	0.57	94.85	4.63	112.45	5.44	15.12
LSD 5%		33.5	0.4	17.7	1.1	59.2	1.5	11.9

PH – plant height
DW – dry weight

Effect of weed control treatments on flax yield and its components

The effect of weed control treatments on number of capsules per plant, number of seeds per capsule, weight of seed per plant (g), weight of 1 000 seeds (g), straw yield (t/ha), seeds yield (kg/ha) and oil yield (kg/ha) at harvest in both tested seasons are shown in table 3.

Data indicated that number of capsules per plant was significantly affected by weed control treatments during the two growing seasons. Results denoted that weed control treatments increased the number of capsules per plant in both seasons as compared to the infested control treatment. This might be attributed to the fact that flax plants in the latter treatment were exposed to severe competition from fibre flax dodder. The highest significant number of capsules per plant was harvested from herbicide butralin treatment, followed by metosulam, tribenuron-methyl, and fluazifop-p-butyl, respectively. These treatments increased the number of capsules/ plant by 66.7, 61.3, 54.3 and 46.2%, respectively in the first season, and by 61.1, 54.2, 49.2 and 44.2% respectively in the second season. The hand combing treatment gave the lowest increase in number of capsules (27.7 and 34.2%) in both seasons, respectively relative to the infested control treatment.

Weed control treatments showed a significant effect on number of seeds per capsule. Generally, fluazifop-p-butyl and hand combing treatments were the inferior treatments in this respect. The butralin, metosulam and tribenuron-methyl treatments were the potent ones. Such findings were true in both the two experimental seasons.

All herbicidal treatments (butralin, metosulam, tribenuron-methyl and fluazifop-p-butyl) increased the weight of seeds per plant significantly in the two tested seasons, as well as the weight of 1 000 seeds in most cases compared to infested control treatment. These results are similar to that reported by Soliman (2002).

Data in table 3 revealed that butralin, metosulam and tribenuron-methyl gave the highest straw yield in both seasons and did not differ significantly in most cases. On the other hand, the control treatment was the worst in straw yield, where it gave the lowest yield. The reduction in straw yield values under hand combing and infested control treatments reflected the negative impacts of flax dodder *C. epilinum* on flax growth, which may be occurred as a result of the competition between flax plants and dodder weed. Also, the results showed that using the tested herbicides was necessary to eliminate this weed and to avoid its negative impacts on crop plants. These results are similar to those reported by Soliman (2002).

Regarding the effect of weed control treatments on seed yield, data denoted that butralin, metosulam and tribenuron-methyl gave the highest seed yield (t/ha), followed by fluozifop-p-butyl. The hand combing treatment gave the lowest seed yield compared to all the tested herbicides. These results showed that a single hand combing was insufficient to provide the desired weed control level and this was reflected on the limited increases in the crop growth and consequently on straw yield. The above results presented in table 3 are in agreement with those obtained by Sher and Shad (1989) and Soliman (2002). These effects might be attributed to the dominant weeds in the hand combing treatment. The results point to the importance of using suitable herbicides to control the expected problem of dodder (*C. epilinum*) weed.

Results in table 3 revealed a slight differences in oil percentage and significant differences in oil yield/ha of flax plants among different weed control treatments in both tested seasons. The highest oil percentage and yield were recorded under butralin followed by metosulam and fluazifop-p-butyl treatments. Meanwhile, the lowest oil yield/ha was obtained from the hand hoeing and infested control treatments relative to uninfested control treatment. Such superiority of these treatments in increasing oil yield per hectare was mainly due to higher seed yield. The lowest oil yield/ha was due to reduction in seed yield reflecting the dominated weed growth.

Table 3. Effect of weed control treatments on flax seed yield and its components at harvesting time during the tested seasons

Treatments	Rate [g a.s./ha]	Number of capsules per plant	Number of seeds per capsule	Weight of seeds per plant	Weight of 1 000 seeds	Straw yield [t/ha]	Seed yield [t/ha]	Oil % of seeds	Oil yield [kg/ha]
Season 1									
Butralin	228.57	15.75	7.58	0.50	8.59	3.7	1.24	38.65	480.2
Metosulam	14.25	13.56	6.63	0.44	8	3.4	1.21	38.18	481.8
Tribenuron-methyl	9.52	11.5	6.11	0.41	7.23	2.9	1.17	38.12	444.8
Fluazifop-p-butyl	297.2	9.75	5.37	0.32	6.56	2.5	0.93	29.08	269.9
Hand combing	–	7.23	4.86	0.28	3.92	1.9	0.55	25.41	139.0
Control (infested)	–	5.23	4.17	0.19	2.89	1.5	0.29	19.37	55.2
Healthy plants	–	16	8.23	0.90	8.95	3.8	1.40	38.95	546.9
LSD 5%		7.66	5.62	0.29	4.38	1.26	0.26		36.51
Season 2									
Butralin	228.57	13.43	7.69	0.64	8.37	3.29	1.26	38.45	485
Metosulam	14.25	11.38	7.12	0.56	7.82	2.93	1.21	38.12	463
Tribenuron-methyl	9.52	10.28	6.62	0.51	7.37	2.83	1.17	38	443
Fluazifop-p-butyl	297.2	9.35	6.02	0.43	6.94	2.36	0.88	31.01	344
Hand combing		7.93	4.84	0.30	4.03	1.88	0.57	25.13	143
Control (infested)		5.22	4.26	0.22	3.93	1.57	0.26	21.17	55
Healthy plants		14.85	8.32	0.88	8.98	3.62	1.36	38.63	524
LSD 5%		9.64	5.16	0.58	4.59	0.97	0.27		41.58

Effect of tested herbicides on chlorophyll and carotene content

Chlorophyll and carotene content of flax plant leaves were estimated after 15, 21 and 35 days from herbicides application. The results of this study were shown as g chlorophyll and carotene per gm of fresh flax plant leaves.

Data presented in table 4 showed the effect of different herbicide treatments as well as dodder weed treatment on chlorophyll and carotene contents of flax plants. The results clearly revealed that chlorophyll and carotene contents were significantly affected by dodder and different herbicide treatments at different times.

The uninfested and untreated flax plants gave the highest chlorophyll a and b contents. On the other hand, the parasitic weed dodder caused a great reduction in chlorophyll a and b contents. At 15 days after application of the tested herbicides, chlorophyll was decreased by about (15.5, 19.4, 20.9 and 24.8%) for flax plants treated with butralin, metosulam, tribenuron-methyl and fluazifop-p-butyl in the first season, and (15.2,18.2, 20.4 and 24.3%) in the second season, respectively.

As for chlorophyll b content, data indicated that chlorophyll b was decreased by (12.1, 14.1, 17.2 and 20.2%) for flax plants treated with butralin, tribenuron-methyl, metosulam and fluazifop-p-butyl in the first season, and (11.7, 17.5, 21.4 and 24.3%) in the second season, respectively as compared to uninfested control. Generally, the same trend was shown at 21 and 35 days after herbicide application with slight differences. Regarding carotene content, data indicated that herbicide application against dodder weed caused great increases in carotene content as compared to healthy uninfested plants. At 15 days after application, flax plant treated with butralin, metosulam, tribenuron-methyl and fluazifop-p-butyl increased carotene content by (18.2, 28.6, 38.6 and 49.3%) in the first season, and (22, 27.8, 36.1 and 40.9%) in the second season, respectively, as compared to the uninfested and untreated control. The same trend was found at 21 and 35 days after herbicides application. The data in this study was similar to the results reported by Ahmed *et al.* (1995) and Soliman (2002).

Effect of the tested herbicides on crude protein content

Data illustrated in table 5 showed the effect of different herbicidal treatments as well as dodder weed on crude protein of flax plants. The obtained results showed that, the parasitic dodder weed caused a great reduction in crude protein at 15, 21, 28, and 35 days in both seasons. Also, the results denoted that butralin, metosulam and tribenuron-methyl had the least effect in inhibition of crude protein content at three times in both tested seasons. While, the herbicide fluazifop-p-butyl had a moderate effect on the inhibition of crude protein content of flax plants. The inhibition percentage in the protein of the flax plant reached 26.38, 29.1, 30.72 and 31.67% in the first season and 26.21, 28.71, 30.7 and 31.24% in the second season at 15, 21, 28 and 35 days, respectively for herbicidal treatments relative to control treatment (uninfested and untreated). These results are in line with the results of Soliman (2002), who reported that herbicide butralin had the least effect in the inhibition of crude protein after thirty-five days of application which implied that the herbicide treatments in this study were less toxic on flax plants.

Table 4. Effect of some herbicides and dodder treatments on chlorophyll and carotene contents [mg/g* fresh weight] of flax plants after 15, 21 and 35 days of application in both tested seasons

Treatments	Rate [g a.s./ha]	15 days			21 days			35 days		
		chlorophyll		carot.	chlorophyll		ca.	chlorophyll		carot.
		A	B		A	B		A	B	
Season 1										
Butralin	228.57	1.09	0.87	0.45	1.28	1.08	0.048	1.38	1.25	0.042
Metosulam	14.25	1.04	0.85	0.49	1.22	1.07	0.057	1.32	1.19	0.044
Tribenuron-methyl	9.52	1.02	0.82	0.57	1.2	1.01	0.066	1.28	1.17	0.04
Fluazifop-p-butyl	297.2	0.97	0.79	0.69	1.14	0.95	0.073	1.24	1.11	0.072
Control (infested)		0.72	0.53	0.98	0.61	0.5	1.13	0.62	0.54	1.18
Healthy plants		1.29	0.99	0.35	1.45	1.17	0.037	1.66	1.41	0.551
LSD 5%		1.10	0.89	1.01	1.62	1.28	1.01	1.55	0.52	
Season 2										
Butralin	228.57	1.12	0.91	0.50	1.26	1.12	0.011	1.35	1.21	0.034
Metosulam	14.25	1.08	0.85	0.74	1.24	1.04	0.027	1.31	1.18	0.047
Tribenuron-methyl	9.52	1.05	0.81	0.61	1.23	1.06	0.042	1.33	1.19	0.051
Fluazifop-p-butyl	297.2	1	0.83	0.66	1.18	0.98	0.059	1.27	1.14	0.063
Control (infested)		0.69	0.51	0.99	0.73	0.62	1.139	0.63	0.54	1.182
Healthy plants		1.32	1.03	0.39	1.47	1.15	0.037	1.6	1.35	0.032
LSD 5%		1.22	0.99	1.09	1.49	0.99	0.87	1.24	0.77	

*mg/g – weight of chlorophyll and carotene determined by mg/g of flax plant leaves; carot. – carotene

Table 5. Effect of some herbicides on crude protein contents [mg/g*] of flax plants at different times after application in both tested seasons

Treatment	Rate [g a.s./ha]	15 days		21 days		35 days	
		[mg/g]	I%**	[mg/g]	I%**	[mg/g]	I%**
Season 1							
Butralin	228.57	9.75	11.92	10.25	9.61	11.23	8.1
Metosulam	14.25	9.54	13.83	9.69	14.55	10.27	15.96
Tribenuron-methyl	9.52	9.43	14.81	9.28	18.17	9.85	19.39
Fluazifop-p-butyl	297.2	8.15	26.38	8.04	29.1	8.35	31.67
Control (infested)		3.15	71.54	2.89	74.51	1.12	90.83
Healthy plants		11.07	0	11.34	0	12.22	0
LSD 5%		10.40		12.45		11.97	
Season 2							
Butralin	228.57	9.51	14.94	10.19	10.53	10.83	9.3
Metosulam	14.25	9.32	16.64	9.46	16.14	9.82	17.76
Tribenuron-methyl	9.52	9.21	17.62	9.21	19.14	9.27	22.36
Fluazifop-p-butyl	297.2	8.25	26.21	8.12	28.71	8.21	31.24
Control (infested)		3.19	71.47	2.91	74.45	2.12	82.24
Healthy plants		11.18	0	11.39	0	11.94	0
LSD 5%		10.0		12.2		12.5	

*mg/g – weight of total protein determined by mg/g of flax plant
**I% – inhibition percentage of the protein weight calculated in relation to the control

CONCLUSIONS

The results showed that dodder weed caused a great decrease in growth characters of flax crop. Hand combing was only suitable to avoid the competition of dodder weed due to their low weed population density. All tested herbicides decreased the infestation with dodder for up to 49 days after treatment of the flax crop. All tested herbicides increased all growth characters relative to infested control treatment. Among the tested herbicides, butralin herbicide gave the best control of dodder, followed by metosulam, tribenuron-methyl and fluazifop-p-butyl. This study suggest that under heavy infestation of soil with dodder weed, it is possible to use the tested herbicides which will give the highest reduction in dodder weed and will increase flax yield and its components.

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POLISH SUMMARY

OCENA NIEKTÓRYCH HERBICYDÓW DO ZWALCZANIA KANIANKI LNU (*CUSCUTA EPILINUM* WEIHE) W LNIE WŁÓKNISTYM (*LINUM USITATISSIMUM* L.)

W stacji doświadczalnej Sakha w Egipcie, prowadzono, w ciągu dwóch sezonów, dwa doświadczenia polowe, w celu oceny skuteczności różnych zabiegów (ręczne odchwaszczanie, butralin, tribenuron metylu, metosulam i fluazifop-p-butylu), zwalczania kanianki (*Cuscuta epilinum* Weihe) w lnie włóknistym. Określano również wpływ tych zabiegów na niektóre cechy wzrostu lnu oraz jego części składowych. Wszystkie sposoby traktowania lnu obniżały zakażenie lnu kanianką przez okres do 49 dni. Wszystkie testowane herbicydy miały pozytywny wpływ na cechy wzrostu lnu. Herbicyd butralin zapewnił najlepsze zwalczanie kanianki. Kolejność skuteczności pozostałych środków była następująca: metosulam, tribenuron metylu i fluazifop-p-butylu. Uzyskane dane wykazały, że większość zabiegów herbicydowych nieznacznie ograniczała zawartość białka w roślinach lnu i nie ograniczała zawartości oleju w nasionach. Badania wykazały również, że przy dużym nasileniu występowania kanianki, użycie testowanych herbicydów, a szczególnie butralinu, jest bardzo potrzebne.