EFFECTS OF THE PHENMEDIPHAM, DESMEDIPHAM, ETHOFUMESATE, METAMITRON AND TRIFLUSULFURON-METHYL ON WEEDS AND SUGAR BEET

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This study was conducted to determine the effect of post-emergence herbicides mixtures on weed dry weight and sugar beet productivity. Additions of metamitron, chloridazon and triflusulfuron-methyl with phenmedipfam + desmedipham + ethofumesate increased the weed spectrum controlled. The addition of metamitron gave effective control of Tripleurospermum perforatum (Merat) M. Lainz., Chenopodium album L., Galium aparine L. and Veronica arvensis L. than chloridazon. Reducing the doses of phenmedipfam + desmedipham + ethofumesate and metamitron gave less control of C. album, T. perforatum. It was noticed that by reducing the rate of phenmedipfam + desmedipham + ethofumesate from 91+71+112 g a.i. ha^{-1} *to 68+53+84 g a.i. ha*$^{-1}$ *in mixture with triflusulfuron-methyl the dry weight of weeds has increased by 75-87%. The herbicides investigated did not have any negative influence on growing and development of sugar beet.*

Key words*: herbicides, weeds, sugar beet.*

Weed competition is one of the major factors which limit sugar beet production in the world [1]. Weed – crop interactions are based on competition for water, nutrients and light and allelopathic effects may also play a small role. In sugar beet weed interference, all these factors are important too, but the light is of prime importance [2]. Due to the fact that a lot of weeds can grow above the sugar beet canopy and reduce the amount of photosynthetic radiation reaching the crop, these weeds are stronger competitors compared to smaller weeds [3, 4].

In much sugar beet growing areas dicot weeds of the families Chenopodiaceae, Asteraceae, Brassicaceae and Polygonaceae are of major importance. The monocots are less important compared to dicot weeds [2, 5].

The optimum weeding period is between 4 and 6 weeks after 50 % crop emergence [6]. Once the optimum weeding time has been reached yield may be depressed by 1.5 % for each day the crop is left unweeded, although sugar beet has some ability to recover from an early check [7].

In order to decrease sugar beet infestation, a complex of agro technical, organizational, chemical and other measures is necessary. However, the most available and justifiable technique is the application of herbicides against the background of high agronomical practices [5]. The effectiveness of pre-emergence residual herbicides decreases with reductions in rainfall or soil wet content [8]. Therefore, less than 10 % of the total sugar beet crop is treated with pre-emergence herbicides. The remaining 90 % depends solely on a selection of post-emergence herbicides to maintain season-long weed control [9]. The major herbicides are phenmedipham, desmedipham, ethofumesate, chloridazon, metamitron, clopyralid, lenacil, triflusulfuron-methyl [10, 11]. Mixtures of post-emergence, broad spectrum herbicides have to be applied to control the wide range of weed species in sugar beet crops [12, 13].

This study was conducted to determine the effect of post-emergence herbicides mixtures on weed dry weight and sugar beet productivity.

MATERIAL AND METHOD

Field experiment was conducted in 2006 and 2007 at the Lithuanian Institute of Agriculture on a light loamy *Endocalcari-Epihypogleyic Cambisols* with pH – 6.6-6.9, humus content – 2.1-2.3 %.

The treatments were phenmedipham + desmedipham + ethofumesate at 68+53+84 and 91+71+112 g a.i. ha^{-1} (Betanal Expert, 274 g l^{-1}, Bayer Crop Science), metamitron at 350 and 525 g a.i. ha^{-1} (Goltix, 700 g kg^{-1}, Makteshim Agan Industries Ltd.) and chloridazon at 650 g a.i. ha^{-1}, (Pyramin Turbo, 520 g l^{-1}, BASF A/S). Information on the herbicides mixtures is reported in *table 1.*

Table 1

Field trial design

Treatments		Dose g a.i. l, kg^{-1} / Application		
		T_{1*}	T_{2*}	T_{3*}
1.	Cleaned manually (control I)	-	-	-
2.	Phenmedipham + desmedipham + ethofumesate + chloridazon, 2772 g a.i. ha^{-1} (control II)	91+71+ 112+ 650	91+71+ 112+ 650	91+71+ 112+ 650
3.	Phenmedipham + desmedipham + ethofumesate + metamitron, 2397 g a.i. ha^{-1}	91+71+ 112+ 525	91+71+ 112+ 525	91+71+ 112+ 525
4.	Phenmedipham + desmedipham + ethofumesate + metamitron (1665 g a.i. ha^{-1})	68+53+84+ 350	68+53+84+ 350	68+53+ 84+350
5.	Phenmedipham + desmedipham + ethofumesate	91+71+ 112	-	-
	Phenmedipham + desmedipham + ethofumesate + triflusulfuron-methyl	-	91+71+ 112+5	-
	Phenmedipham + desmedipham + ethofumesate + triflusulfuron-methyl (837 g a.i. ha^{-1})	-	-	91+71+ 112+10
6.	Phenmedipham + desmedipham + ethofumesate	68+53+ 84	-	-
	Phenmedipham + desmedipham + ethofumesate + triflusulfuron-methyl (630 g a.i. ha^{-1})	-	68+53+ 84+7,5	68+53+ 84+7,5

* - T_1 - first application, T_2 – second application, T_3 – third application.

The experiment was carried out in 4 replications. Plot size 8.1 m^2. The herbicides applied three times. The first application was done at the early cotyledon stage of weed growth. Subsequent applications were applied when the next weeds flush emerged or 10-17 days after the first flush. Sprayings were applied at a water volume equivalent to 200 l ha^{-1}. Four weeks after treatments dry weights of weeds were recorded. At the time of assessment a quadrate of 0.20 m x 1.25 m was randomly thrown in each plot. The weeds in sugar beet stand were removed manually 3 times. Sugar beet was hand harvested from central three rows in each plot on October each year.

Extractable sugar was calculated according to Reinefeld formula [14]. The data were analysed with ANOVA and LSD test. Weed dry weight data were transformed to $\sqrt{x+1}$.

RESULTS AND DISCUSSIONS

Weed dry weight. The weed spectrum differed between years. In 2006 *Chenopodium album* L., *Tripleurospermum perforatum* (Merat) M. Lainz., *Galium aparine* L., *Viola arvensis* Murray, *Veronica arvensis* L., *Euphorbia helioscopia* L., *Sinapis arvensis* L. was dominating weed flora, while in 2007 *C. album*, *T. perforatum*, and *G. Aparine* were the most prevalent weed species. The results showed that applications of phenmedipham + desmedipham + ethofumesate + metamitron (2397 g a.i. ha^{-1}) generally gave the greatest weed control (*tab. 2*). The addition of metamitron gave effective control of *T. perforatum*, *C. album, G. aparine, Veronica arvensis* and *S. arvensis* than chloridazon. Similar causes of metamitron effectivenes have been reported by many authors [13, 15]. Reducing the doses of phenmedipfam + desmedipham + ethofumesate and metamitron (1665 g a.i. ha^{-1}) gave less control of *C. album, T. perforatum, G. aparine* and *Veronica arvensis* compared with control II. The herbicide mixtures did not have significant influence on weight of botanical composition of weed flora, except for *C. album.*

Table 2

Prevailing weeds dry weight four weeks after treatments, g m^{-2}

Treatments		CHEAL	GALAP	MATIN	VIOAR	VERAR	SINAR
2.	P + D + E + CH, 2772 g a.i. ha^{-1} (control II)	2.07	0.39	0.85	0.13	0.02	0.16
3.	P + D + E + M 2397 g a.i. ha^{-1}	0.40	0.19	0.02	0.12	0.02	0.00
4.	P + D + E + M (1665 g a.i. ha^{-1})	2.19	0.87	1.47	0.11	0.18	0.19
5.	P + D + E	2.91	0.26	1.32	0.03	0.07	0.00
	P + D + E + T						
	P + D + E + T (837 g a.i. ha^{-1})						
6.	P + D + E	16.45**	1.44	0.71	0.29	0.22	0.00
	P + D + E + T (630 g a.i. ha^{-1})						

P – phenmedipham, D – desmedipham, E – ethofumesate, M – metamitron, CH – chloridazon, T – triflusulfuron-methyl; CHEAL – *Chenopodium album,* GALAP – *Galium aparine,* MATIN – *Tripleurospermum perforatum,* VIOAR – *Viola arvensis,* VERAR – *Veronica arvensisi,* SINAR – *Sinapis arvensis;* ** - differences significant at the 1% level respectively.

It was noticed that effectiveness before harvest of additions chloridazon and metamitron was similar (*tab. 3*). Reducing rate of phenmedipfam + desmedipham + ethofumesate from 91+71+112 g a.i. ha^{-1} to 68+53+84 g a.i. ha^{-1} in mixture with triflusulfuron-methyl the dry weight of *C. album* has increased significantly but that of *T. perforatum* - significantly decreased.

Table 3

Prevailing weeds dry weight before harvest, g m^{-2}

Treatments		CHEAL	MATIN	VIOAR	VERAR	EPHHE
2.	P + D + E + CH, 2772 g a.i. ha^{-1} (control II)	0.63	0.86	0.33	0.20	0.11
3.	P + D + E + M 2397 g a.i. ha^{-1}	0.99	0.00*	0.08	0.03	0.02
4.	P + D + E + M (1665 g a.i. ha^{-1})	0.04	0.18	0.08	0.14	0.00
5.	P + D + E P + D + E + T P + D + E + T (837 g a.i. ha^{-1})	1.18	0.04*	0.05	0.0	0.11
6.	P + D + E P + D + E + T (630 g a.i. ha^{-1})	9.52**	0.00*	0.28	0.0	0.00

P – phenmedipham, D – desmedipham, E – ethofumesate, M – metamitron, CH – chloridazon, T – triflusulfuron-methyl; CHEAL – *Chenopodium album,* GALAP – *Galium aparine,* MATIN – *Tripleurospermum perforatum,* VIOAR – *Viola arvensis,* VERAR – *Veronica arvensisi,* EPHHE – *Euphorbia helioscopia;* *, ** - differences significant at the 5%, 1% level respectively.

The weakest effect on weed control was obtained after commercial mixture of phenmedipham + desmedipham + ethofumesate + triflusulfuron-methyl (630 g a.i. ha^{-1}) application (*tab. 4*).

Table 4

Total weeds dry weight, g m^{-2}

Treatments		4 weeks after treatments	Before harvest
2.	Phenmedipham + desmedipham + ethofumesate + chloridazon, 2772 g a.i. ha^{-1} (control II)	3.8	2.2
3.	Phenmedipham + desmedipham +ethofumesate + metamitron (2397 g a.i. ha^{-1})	0.8*	1.1
4.	Phenmedipham + desmedipham + ethofumesate + metamitron (1665 g a.i. ha^{-1})	5.2	0.4
5.	Phenmedipham + desmedipham +ethofumesate;	4.8	1.4
	Phenmedipham + desmedipham +ethofumesate + triflusulfuron-methyl;		
	Phenmedipham + desmedipham +ethofumesate + triflusulfuron-methyl (837 g a.i. ha^{-1})		
6.	Phenmedipham + desmedipham +ethofumesate; Phenmedipham + desmedipham +ethofumesate + triflusulfuron-methyl (630 g a.i. ha^{-1})	19.4**	10.4**

*, ** - differences significant at the 5%, 1% level respectively.

Total weeds dry weight significantly increased after application there commercial mixture was used as compared with control II. It was noticed that by reducing the rate of phenmedipfam + desmedipham + ethofumesate from 91+71+112 g a.i. ha^{-1} to 68+53+84 g a.i. ha^{-1} in mixture with triflusulfuron-methyl the dry weight of weeds has increased by 75-87 %. When the dose of metamitron and phenmedipfam + desmedipham + ethofumesate (1665 g a.i. ha^{-1}) in a herbicide mixture was reduced the weeds weight has increased.

Sugar beet yield and quality. In 2006 sugar beet root yield varied from 74.8 t ha^{-1} for cleaned manually (control I) to 70.4-71.8 t ha^{-1} for herbicides mixtures application (*fig. 1*). Root yield variation was small and no statistically significant. In 2007 sugar beet varied from 69.6 t ha^{-1} for the control II to 69.4-74.3 t ha^{-1} for treatments with herbicide application. The least roots yield of sugar beet was registered after mixture of phenmedipham + desmedipham + ethofumesate + triflusulfuron-methyl (837 g a.i. ha^{-1}) application, while the highest one was obtained when the metamitron (1667 g a.i. ha^{-1}) has been added in the mixture of phenmedipham + desmedipham + ethofumesate.

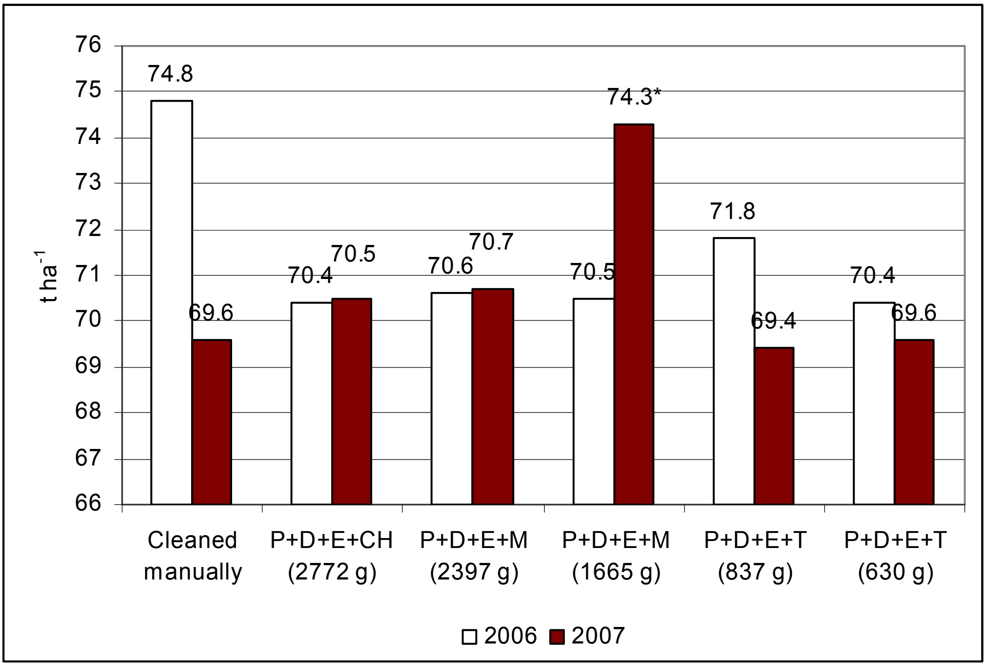

Figure 1 **Root yield in individual years**

The lower root sugar content in 2006 is the result of unfavourable weather conditions – dry and hot summer as well as rainy and warm autumn that resulted in summer leaves drying and intensive autumn regrowth causing higher sugar consumption from sugar beet root (*fig. 2*). In the trials published by Jozefyová et al., the technological quality of sugar beet roots depends of precipitations and temperatures [16, 17].

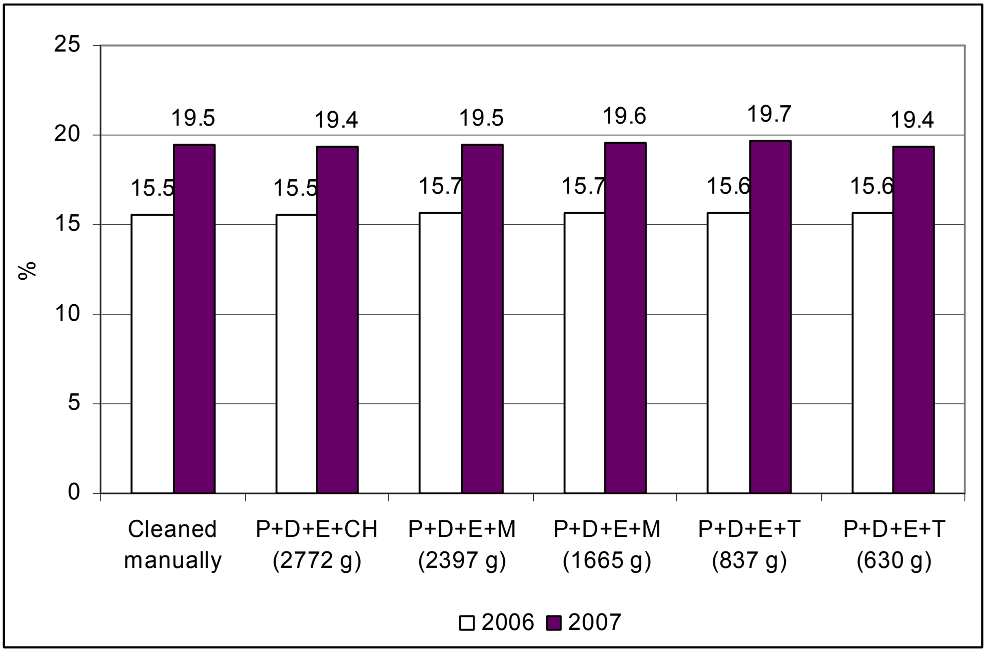

Figure 2 **Sugar content in individual years**

The corrected sugar (white sugar) content is dependent on many root features: morphological – size and shape, physical – tissue elasticity, physiological

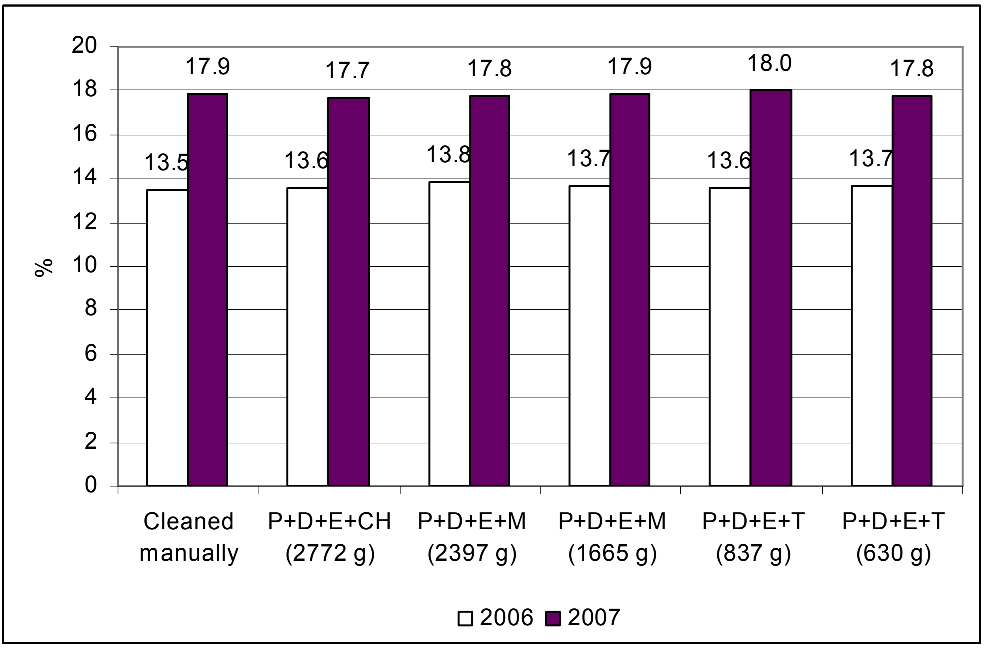

Figure 3 **White sugar content in individual years**

– intensity of constituent roots' respiration on piles before processing, chemical – saccharose content, and content of melassigenic substances impeding sugar extraction [16]. White sugar content varied in years (*fig. 3*). The herbicides did not have any negative influence on white sugar content.

Significant differences between individual treatments occurred mainly in 2007 (*fig. 4*). The highest white sugar yields occurred in the treatment where the herbicide mixture phenmedipham + desmedipham + ethofumesate were used with chloridazon (2772 g a.i. ha^{-1}) and metamitron (1665 g a.i. ha^{-1}). In 2006 white sugar yield showed not statistically significant differences between individual treatments.

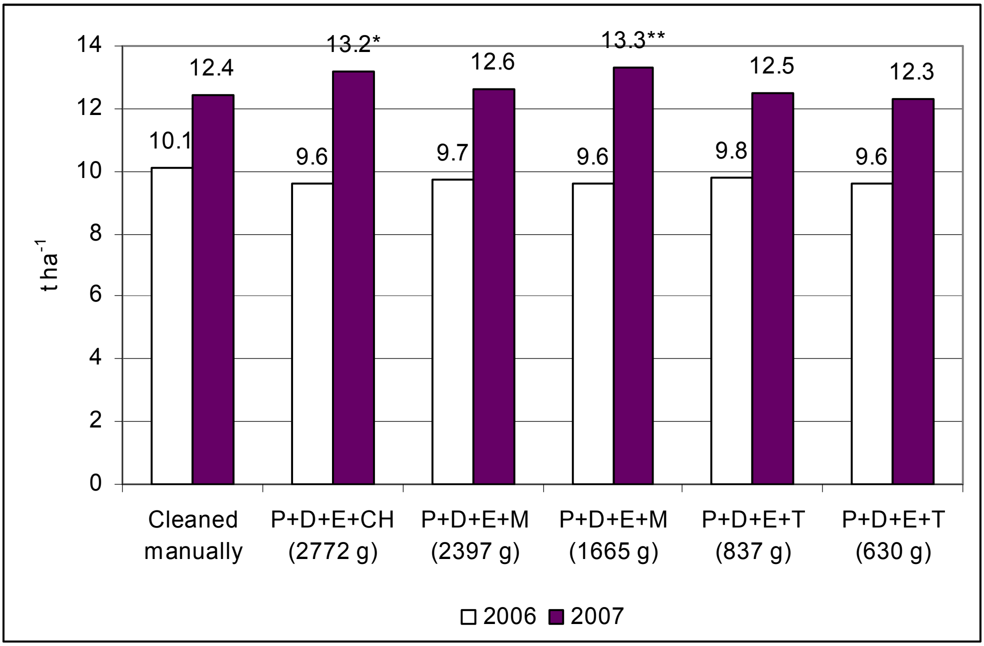

Figure 4 **White sugar yield in individual years**

Sugar beet root yield was lowest in herbicides applications treatments than in cleaned manually, except variant where phenmedipham + desmedipham + ethofumesate + metamitron (1665 g a.i. ha^{-1}) were used (*tab. 5*). The least root yield was registered for phenmedipham + desmedipham + ethofumesate + triflusulfuron-methyl (630 g a.i. ha^{-1}), when the rate of phenmedipham + desmedipham + ethofumesate redused by reducing the rate of phenmedipfam + desmedipham + ethofumesate from 91+71+112 g a.i. ha^{-1} to 68+53+84 g a.i. ha^{-1}. In this treatment the highest weed weight has been registered. Crop yield was not significantly different between herbicide treatments. Similar results have been reported previously [12].

Sugar and white sugar content and white sugar yield were not affected by the herbicide treatments. Similar results were also obtained by Abdollahi and Ghardi [18].

Table 5

Comporison of production indicators of sugar beet (2006-2007)

	Treatments	Root yield, t ha^{-1}	Sugar content %	White sugar content %	White sugar t ha^{-1}
1.	Cleaned manually (control I)	72.2	17.5	15.7	11.3
2.	Phenmedipham + desmedipham + ethofumesate + chloridazon, 2772 g a.i. ha^{-1} (control II)	70.4	17.4	15.6	11.4
3.	Phenmedipham + desmedipham + ethofumesate + metamitron (2397 g a.i. ha^{-1})	70.6	17.6	15.8	11.2
4.	Phenmedipham + desmedipham + ethofumesate + metamitron (1665 g a.i. ha^{-1})	72.4	17.6	15.8	11.5
5.	Phenmedipham + desmedipham + Ethofumesate;	70.6	17.6	15.8	11.1
	Phenmedipham + desmedipham + ethofumesate + triflusulfuron-methyl;				
	Phenmedipham + desmedipham + ethofumesate + triflusulfuron-methyl (837 g a.i. ha^{-1})				
6.	Phenmedipham + desmedipham + Ethofumesate;	70.0	17.5	15.7	11.0
	Phenmedipham + desmedipham + ethofumesate + triflusulfuron-methyl (630 g a.i. ha^{-1})				

CONCLUSSIONS

Phenmedipham, desmedipham, ethofumesate was more effective for controlling *Chenopodium album, Tripleurospermum perforatum Galium aparine, Veronica arvensis* and *Sinapis arvensis* by applying in a mixture with metamitron than by applying in a mixture with chloridazon.

Reducing the doses of phenmedipfam + desmedipham + ethofumesate from 91+71+112 g a.i. ha^{-1} to 68+53+84 g a.i. ha^{-1} in mixture with triflusulfuron-methyl the dry weight of *C. album*, *T. perforatum, G. aparine* and *V. arvensis* has increased. The dry weight of weeds has increased by 75-87%.

The herbicides investigated did not have any negative influence on sugar beet productivity and quality.

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