THE EFFECT OF IMIDAZOLINONE AND TRIBENUROM-METHYL TOLERANT SUNFLOWER TECHNOLOGY ON WEED CONTROL EFFICENCY AND SOIL QUALITY

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Abstract

During the period 2012-2013 in Mostistea Plain, Fundulea, South-Est of Romania on experimental conditions, under non irrigated conditions on cambic chernozem soil was carried out a field experiment with sunflower (*Helianthus annuus*). The paper presents the results concerning the weed control efficency of the imidazolinone and tribenurom-methyl tolerant sunflower technology and their effect on soil quality. Treatments with herbicides imazamox and tribenuron-methyl were applied to sunflower using technologies and specific resistant hybrids. Beside herbicide Express® 50 SG (sulfonylureas chemical group) was used the herbicide Frontier Forte (dimethenamid-P) and Stratos Ultra® (cicloxidim). In the year 2013 the degree of weed infestation was higher due to heavy rainfall, but we got a good weed control with the cultivation of IMI and SU sunflowers in both years. Enzyme activity from soil expressed as catalase activity was similar to untreated control for sunflower treated pre-emerget with Frontier Forte®. Treatments applied postemergence (Imazamox, Trimenuron-methyl) had either positive or values comparable to untreated control.
It showed an increase of cellulolytic activity after two month from herbicide treatments, suggesting an improvement in soil biological conditions. The herbicides Frontier Forte® (pre-emergence) and Pulsar® 40 at post-emergence application did not affect soil respiration, which suggests that these herbicides did not affect life from the soil. The fact that in the case of pre-emergent herbicide Frontier Forte®, soil respiration is relatively low compared to the untreated control suggests that microbial degradation was dificient at the moment. In respect of the nitrogen fixed nonsimbiotic our results shown that after 10 days and one month of treatments application, the values were comparable to the control, suggesting that the insignificant difference between the mean values of atmospheric dinitrogen fixed-free (nonsimbiotic) can be interpreted as lack of influence of herbicide treatment.

Key words:

As a result of sunflower breeding over the past several years, new hybrids have been developed and introduced in commercial farm production, thus an increasing area is seeded with of herbicide tolerant sunflower hybrids. A large proportion of Romanian farmers tend to apply the CLEARFIELD® technology along with the application of sunflower hybrids resistant to herbicide substance imazamox, as well as sunflower hybrids resistant to tribenuron-methyl. The main advantages consist in efficiency against dicotyledonous weeds (*Cirsium, Xanthium, Chenopodium, Sorghum*), considered "weed problem" for Romanian conditions and efficacy against parasitic weed *Orobanche cumana*, which became a big problem with intensifying drought (Delckev, 2013).

Herbicides will remain in future agriculture an effective tool for weed control as part of integrated management of weeds, and to optimize their use (Jocić et al., 2011; Knežević et al., 2011) will be necesary integrated study. In this respect the aim of this study was both to determine the efficacy of the imidazolinone and tribenurom-methyl tolerant sunflower technology on weed control and to evidentiate their effect on soil quality.

MATHERIAL AND METHODS

The plots field trials were performed in Mostistea Plain, Fundulea, South-Est of Romania on experimental conditions, under non irrigated conditions of the years 2012 and 2013. The experiment was carried out by the block method, in three replications, size of the experiment plot 25 m^2, on cambic chernozem soil, after predecessor winter wheat in 2012 and winter rape în 2013. A total of 9 variants were investigated. Active substance and doses of investigated herbicides are shown in *table 1*.

The post-emergence treatments were applied in 14-16 BBCH growth stage of sunflower. Because herbicide Express® 50 SG has a low adhesion of the

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weeds it was mixed in tanck with adjuvant Trend® 90 using a 0,1 % concentration (250 ml/ha). Pulsar® 40 was used without the mixing in application any adjuvant.

The efficacy of herbicides against weeds was assessed as procent of damages (0%=no damage, 100%=total damages).

Soil samples were performed from the plow horizon (0-10 cm) and were tested for respiration, cellulose biodegradation potential (Stefanic methods, 2014) and nonsymbiotic nitrogen-fixed (Stefanic and Oprea method, 2010). Cellulolytic activity is expressed in % cellulose degraded, respiration in mg CO_2 from 100 g of soil and dinitrogen fixation in N_2 fixed/ha.

Table 1

Investigated variants

Treatments	Active ingredients	Time of application	Doses rate, (l, g)/ha
Conventional technology – hybrid: Performer			
Check untreated	-		
Frontier Forte®	720 g/l Dimethenamid-P	Pre-emergence	1,4
Stratos Ultra® + Dash® HC	100 g/l Cicloxidim + adjuvant	32-33 BBCH	2 + 2
Clearfied® technology – hybrid LG 56.63			
Check untreated			
Pulsar® 40	40 g/l Imazamox	14-16 BBCH	1,2
ExpressSun technology – hybrid PR64LE20			
Check untreated			
Frontier Forte®	720 g/l Dimethenamid-P	Pre-emergence	1,4
Express® 50 SG + Trend® 90	50 g/kg Tribenuron-methyl + adjuvant	14-16 BBCH	30 +0,1%
Stratos Ultra® + Dash® HC	100 g/l Cicloxidim+ adjuvant	32-33 BBCH	2+2

RESULTS AND DISCUSSIONS

The years of experimentation were totally different from the viewpoint of quantity and monthly repartition of rainfall. The average of monthly temperatures in the growing season of crops were above the annual average, on average 1.9°C in 2012 and 1.2°C in 2013. There was a deficit of rainfall in the early part of the growing season, followed in May by precipitations that exceeded the normal of the zone and again a deficit of rainfall in June, insufficient to meet water needs of crops. In 2013 year, the cumulated rainfall exceeded with mm the normal of the zone (mm), (*table 2*).

Dominant weeds that determine secondary weeding in the experiment field are annual broadleaved species *Xanthium strumarium, Amaranthus retroflexus, Chenopodium album, Solanum nigrum, Portulaca oleraceae, Sinapis arvense, Polygonum aviculare, Galinsoga parviflora and Hibiscus trionum*. Annual grassy weeds are represented by *Echinochloa crus-galli, Digitaria sangvinale, Setaria viridis, Setaria glauca*. Perennial species in the experiment are broadleaved weeds *Cirsium arvense, Polygonum convolvulus, Convolvulus arvensis* and grassy weed *Sorghum helepense* mainly by rhizomes.

In this experimental conditions the Dimethenamid-P herbicide had a lower efficacy against *Xanthium strumarium, Cirsium arvense and Convolvulus arvensis* (*table 3*).

Herbicide based on Imazamox destroys a large number of weeds species like: *Echinochloa crus-galli, Digitaria sangvinale, Setaria viridis, Setaria glauca, Amaranthus retroflexus, Chenopodium album, Solanum nigrum, Portulaca oleraceae, Sinapis arvense, Poligonum aviculare, Hibiscus trionum, Sinapis ervanse, Raphanus rapfanistum, Papaver rhoes, Poligonium convolvulus, Galinsoga parviflora, Capsella bursa-pastoris,* etc.

Table 2

Average temperature (°C) and monthly distribution of rain fall (mm) during the crop vegetation period. Fundulea, 2012-2013

Month	March	April	May	June	July	August	September	Average/ Sum
Temperature 2012	5.4	14.2	18	23.3	27.2	25.1	19.5	18.96
Temperature 2013	4.9	13.2	18.9	21.7	23.1	23.8	16.8	17.49
Multi-annual average	*4.7*	*11.1*	*16.9*	*20.6*	*22.5*	*22*	*17.2*	*16.43*
Differences 2012	*0.7*	*3.1*	*1.1*	*2.7*	*4.7*	*3.1*	*2.3*	2.53
Differences 2013	*0.2*	*2.1*	*2*	*1.1*	*0.6*	*1.8*	*-0.4*	1.06
Rainfall 2012	4.8	35.1	159.5	20.7	2	47.8	49.1	319.00
Rainfall 2013	39	38.5	97.1	126.7	96.1	22.2	91.4	511.00
Multi-annual average	*37.5*	*44.6*	*59*	*72.3*	*72.2*	*51*	*50.1*	*386.70*
Differences 2012	-32.7	-9.5	100.5	-51.6	-70.2	-3.2	-1	-67.70
Differences 2013	1.5	-6.1	38.1	54.4	23.9	-28.8	41.3	124.30

Table 3

Efficacy of some vegetation herbicides against annual broadleaved weeds and grasses in sunflower according to the 100 % visual scale of assessment. Fundulea 2012-2013

Weeds	Check untreated		Dimetenamid-P pre-emergent 24 DAT		Cicloxidim post-emergent 21 DAT		Imazamox 21 DAT		Tribenuron-methyl 21 DAT	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Xanthium strumarium	0	0	0	0			100	98	90	98
Amaranthus retroflexus	0	0	85	90			95	98	85	97
Chenopodium album	0	0	75	85			85	95	80	85
Solanum nigrum	0	0	85	90			98	100	85	87
Galinsoga parviflora	0	0	78	85			98	100	95	98
Hibiscus trionum	0	0	50	75			85	90	95	98
Portulaca oleracea	0	0					90	95	95	98
Sinapis arvense	0	0	40	75			95	98	97	98
Cirsium arvense	0	0					75	80	85	95
Setaria viridis	0	0	95	98			95	98	0	0
Setaria glauca	0	0	90	98			90	98	0	0
Echinochloa-crus-galli	0	0	85	95	98	100	95	100	0	0
Sorghum halepense	0	0			98	100	78	85	0	0

This herbicide completely destroy *Xanthium strumarium* as well. Imazamox controls successfully perennial weeds - *Sorghum helepense* from seeds and rhizomes, *Cirsium arvense* and *Convolvulus arvensis*. Imazamox fully controls *Orobanche cumana*. *Orobanche cumana* grows with the sunflower and is then destroyed by the herbicide. On one side Imazamox has completed control against this parasitic weed and on the other side the herbicide decreases its seed reserve from the soil.

Herbicide based on Tribenuron-methyl controls very well all perennial and annual broadleaved weeds like: *Cirsium arvense, Convolvulus arvensis, Amaranthus retroflexus, Chenopodium album, Solanum nigrum, Datura stramonium, Abutilon theophrasti, Portulaca oleraceae, Sinapis arvense, Poligonum aviculare, Hibiscus trionum, Sinapis arvanse, Raphanus rapfanistum, Papaver rhoes, Poligonium convolvulus, Galinsoga parviflora, Capsella bursa-pastoris*, etc., and it is inefficient against annual grasses and perenial grasses, too.

The obtained seed yields are the result of the effect of the efficacy of the investigated herbicides. The highest seed yield is obtained using the technology Clearfield, (*table 4*).

Enzyme activity from soil expressed as catalase activity was similar to untreated control for sunflower treated pre-emerget with Frontier Forte. Treatments applied postemergence (Imazamox, Trimenuron-methyl, Cicloxidim) had either positive or values comparable to untreated control under 2012 and under climatic conditions of 2013 the herbicides not affected significant catalase activity, (*table 5*).

It showed an increase of cellulolytic activity after two month from herbicide treatments, suggesting an improvement in soil biological conditions (*figure 1*).

Table 4

Influence of some herbicides and on seed yield of sunflower (2012 - 2013)

Technology	Yeld seeds, 2012 (kg/ha)	Yeld seeds, 2012 (kg/ha)	Average, 2012-2013 (kg/ha)
Check untreated	2130	2470	2300
Conventional	2450	2614	2532
Express SUN	2890	2960	2925
CLEARFIELD	2930	3110	3020

Table 5

Influence of some herbicides applied to sunflower on soil cellulolytic activity. Fundulea, 2012-2013

Pre-emergent treatment	Cellulolytic activity (% cellulose degraded)		Post-emergent treatment	Cellulolytic activity (% cellulose degraded)	
	2012	2013		2012	2013
Check untreated	11.72	12.10	Check untreated	2.83 b	7.25 a
Dimetenamid-P	10.28	10.85	Tribenuron methyl	7.63 a	8.25 a
LSD 5%	4.25	3.58	Cicloxidim	4.21 a	6.32 a
			Imazamox	2.51 b	5.86 a
			LSD 5%	4.06	3.12

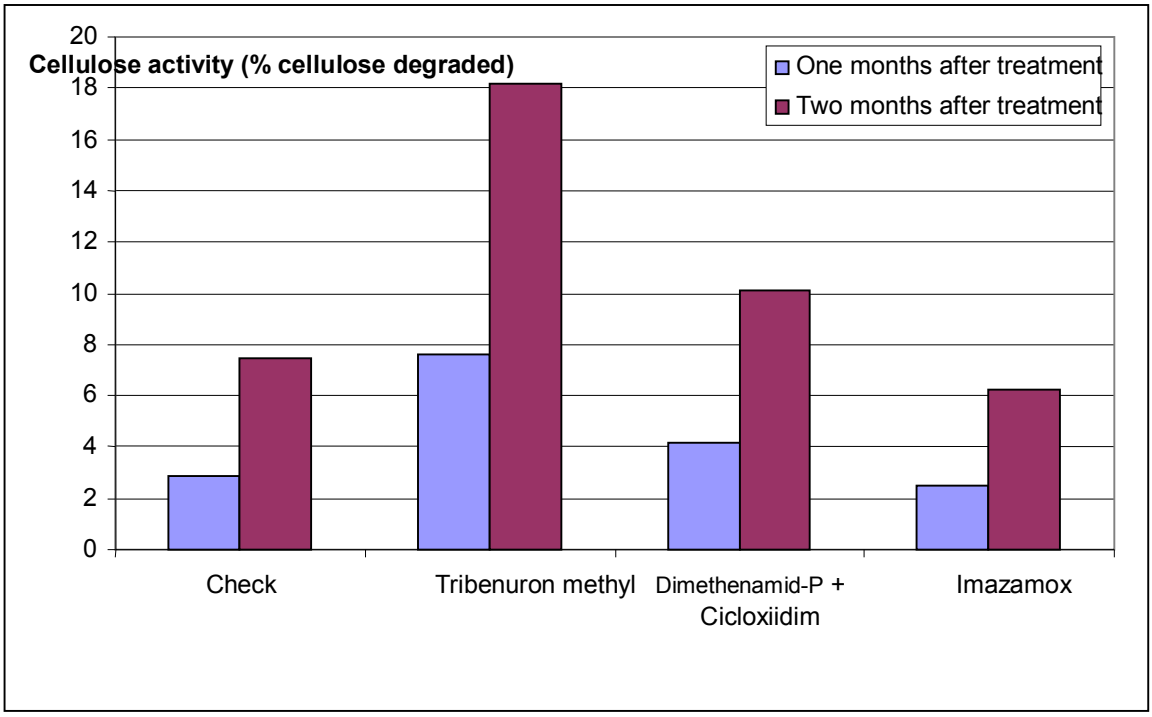

Figure 1 **Cellulolytic activity in soil after application of herbicides. Fundulea, 2012.**

The herbicides with Cicoxidim and Imazamox at post-emergence application did not affect soil respiration, which suggests that these herbicides did not affect life from the soil. The fact that in the case of pre-emergent herbicide Dimethenamid-P, 2012, soil respiration is relatively low compared to the untreated control suggests that microbial degradation was dificient at the moment, (table 6).

Recent data from the literature shows that non-symbiotic nitrogen fixation in soil is quantitatively negligible, as previously believed (Feher, 1954 and Eliade, 1977 quote by Stefanic, 2012) but on the contrary quantities of nitrogen fixed-free (non-symbiotic) can reach 190-245 kg / ha / month (Stephen et al., 2012). It is known that pesticides, in general, reduce the ability of symbiotic nitrogen fixation (Fox et al. 2007).

Our results shown that after 10 days and one month of treatments application, the values were comparable to the control, suggesting that the insignificant difference between the mean values of atmospheric dinitrogen fixed-free (nonsimbiotic) can be interpreted as lack of influence of herbicide treatment, (*table 7*).

Table 6

Influence of herbicides applied to sunflower crop on soil respiration. Fundulea, 2012-2013

Pre-emergent treatment	Respiration (mg CO_2/100 g of soil)		Post-emergent treatment	Respiration (mg CO_2/100 g of soil)	
	2012	2013		2012	2013
Check untreated	91.44 a	95.58 a	Check untreated	39.66 b	41.24 b
Conventional (Dimethenamid-P)	58.57 b	84.42 a	Tribenuron methyl	85.69 a	66.66 a
LSD 5%	14.97	10.20	Cicloxidim	44.75 b	44.48 b
			Imazamox	42.70 b	42.6 b
			DL 5%	28.76	16.41

Table 7

Dynamics of atmospheric dinitrogen fixed-free within 30 days of incubation.Fundulea, 2012, 2013

Variants	Sol recoltat la 10 zile de la tratament		Sol recoltat la o luna de la tratament	
	N_2–free-fixed (mg/100 g soil)		N_2–free-fixed (mg/100 g soil)	
	2012	2013	2012	2013
Check untreated	3.025 a	6.18 a	6.010 a	6.18
Tribenuron Methyl	2.027 a	3.35 a	5.979 a	3.93
Imazamox	6.004 a	2.94 a	4.504 a	3.11
LSD 5%	8.10	4.25	8.98	4.30

CONCLUSIONS

Imazamoxherbicide by Clearfield technology and Tribenuron Methyl herbicide by ExpressSun technology completely destroyed all annual and perennial grassy and broadleaved weeds. The obtained seed yields are the result of the effect of the efficacy of the investigated herbicides.

Enzyme activity from soil expressed as catalase activity depended on the type of herbicide and climatic conditions. Under drought conditions (2012) some herbicides (Tribenuron-methyl, Cicloxidim) have a positive effect while under climatic conditions of 2013 the herbicides not affected significant catalase activity from soil.

Application of herbicides, with the exception of Frontier Forces in 2012 did not affect soil respiration.

Soil capacity for non-symbiotic nitrogen fixation was not diminished by treatments performed in both years of experimentation.

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