Researches Regarding Weed Control in Soybean Crop

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Abstract

Soybean shows special sensitivity to weeding while in the early growth stages until the land is covered, but also in the mature stages after the leaves begin to fall. Once invaded by weeds, especially in the first phase of growth, the culture is no longer recovering even if later, weeds are controlled. The purpose of presented paper is to identify an integrated weed control system for the soybean crop, starting from: (i) requirements of the soybean crop towards environmental and technological factors so that it can effectively compete with weeds; (ii) reporting the weed control strategy to new climatic conditions through specific measures of adaptation; (iii) strategies research of chemical complementary herbicides regarding their combat range and time of application. In order to maintain soybean cultures clean of weeds, it is necessary, in general, to apply two chemical treatments, the first ppi/pre-emergent spraying for some annual dicotyledonous and monocotyledonous weeds and the 2nd post-emergence treatment for dicotyledonous weeds. If on vegetation exists infestations both with annual or perennial monocotyledonous weeds, good results are obtained by associating two complementary herbicides, which combat both monocotyledonous and dicotyledonous weeds. The lowest degree of weed (7.5 weed/m²) was determined with the combination: Frontier Forte & Surdone & Pulsar & Stratos Ultra.

Keywords: *weed control, chemical strategies, soybean.*

INTRODUCTION

Soybean is one of the most famous and valuable agricultural plants, being useful for human consumption, animal nutrition and industry (Muntean et al., 1995; Duda et al., 2008). Soybean being a legume, contributes substantially to increasing the fertility of the soil, but can also be the main feedstock for bio-diesel (USA and Brazil). Thermal resources constitute one of the main limiting factors in expanding this culture in the northern areas, while in the southern, the efficiency of the culture is conditioned as a rule, by water resources (Rusu, 2001; Domuta et al., 2012; Moraru and Rusu, 2013; Roman, 2013). Soy shows special sensitivity to weeding while in the

early growth stages until the land is covered, but also in the mature stages after the leaves begin to fall. Once invaded by weeds, especially in the first phase of growth, the culture is no longer recovering even if later, weeds are controlled. Soy being a plant with small-middle size is part of a group of agricultural plants easily competed by weeds, thus resulting in large production losses (30-80%), sometimes compromising the whole culture. (Berca, 2004; Avola et al., 2008). The most common encountered weeds in soybeans are in particular those with late spring germination, but not exclusively (Sartorato et al., 1996; Gus et al., 2004; Rusu et al., 2012): *Echinochloa crus-galli*, *Setaria sp.*, *Digitaria sanguinalis*, *Sorghum*

halepense, *Agropyron repens*, *Solanum nigrum*, *Amaranthus retroflexus*, *Chenopodium album*, *Galinsoga parviflora*, *Xanthium sp.*, *Abutilon teophrastris*, *Datura stramonium*, *Polygonum sp.*, *Cirsium arvense*, *Convolvulus arvensis* etc.

Explosive weeding in the soybean crop (due to late spring sowing when all vegetation revives explosively) extremely diversifies infestation and ratio variability of weed species and requires a specific strategy of integrated weed control, based on reducing their number below the economic threshold of pest. Climate warming of the past few years, require specific measures of adapting this strategy, especially of technological nature, for the soybean crop. Thus, the amount of biologically active degrees registered for soybeans, in the monitoring period 2008-2012 in the Transylvanian Plain, ranges between 1044-1568°C ($T > 8^{\circ}\text{C}$, 150 days), placing the soybean in the II, III and IV culture zones (Weindorf et al., 2009; Rusu et al., 2014). Thus, varieties with extended period of vegetation can be grown, more productive, but in the same period, 38.9% of the vegetation period, the humidity recorded is below the optimal moisture range. Meanwhile, as the habitat is degraded due to climate change, plant species that will survive are those with a short life cycle, which can adapt and spread more easily. These changes have led to the invasion of specific weed species such as *Xanthium sp.* Seeds of the species germinate at elevated temperatures of 20-30°C, at a depth of 2-10 cm. Germination is staggered, depending on the temperature, humidity of the ground and the depth of the embedding. The first time germinates the seed from lower achenes, while seeds from higher achenes germinate only when the first one was destroyed by tillage, hoeing or herbicides. In these circumstances, the most important aspect of the applied technology is to conserve water in soil through minimum tillage or direct seeding, providing mulch on the soil's surface and preventive control of weeds. Sufficient moisture in the soil is the main condition for obtaining good results.

The purpose of presented paper is to identify an integrated weed control system for the soybean crop, starting from: (1) requirements of the soybean crop towards environmental and technological factors so that it can effectively compete with weeds; (2) reporting the weed control strategy to new climatic conditions through specific measures

of adaptation; (3) strategies research of chemical complementary herbicides regarding their combat range and time of application.

MATERIALS AND METHODS

Research was conducted in the agricultural year of 2013-2014 at SCDA Turda, located in the physical-geographical area of Transylvanian Plain on a vertic faeoziom soil type with clay-loamy texture, neutral pH, good and very good supply of mobile phosphorus and potassium, soil's humus content being average.

As mono-factorial experience, is organized within the demonstrative Donau Soja Platform, following the placed end to end blocks method (storied). As biological material was used Felix soybean variety (group of maturity 00, vegetation period 122 days) created by Agricultural Research and Development Station, Turda (SCDA Turda). It is a variety with high waist suitable to mechanical harvesting with basal pods insertion height of 16 cm and a good resistance to pests and diseases.

Experimental variants are:

V_1 – Frontier Forte (*dimetenamid-P* 720 g/l) 1.4 l/ha + Surdone (*metribuzin* 700 g/kg) 0.4 kg/ha (+ Trend 250 ml/ha) preem + Pulsar 40 (*imazamox* 40 g/l) 1 l/ha postem early + Stratos Ultra (*cicloxidim* 100 g/l) 3 l/ha postem;

V_2 – Stomp 330 EC (*pendimetalin* 330 g/l) 5 l/ha + Surdone (*metribuzin* 700 g/kg) 0.4 kg/ha (+ Trend 250 ml/ha) preem + Basagran Forte (*bentazon* 480 g/l + *wettol* 150 g/l) 2 l/ha + Agil 100 EC (*propaquizafop* 100 g/l) 0.8 l/ha postem (tank-mix);

V_3 – Surdone (*metribuzin* 700 g/kg) 0.5 kg/ha (+ Trend 250 ml/ha) preem + Harmony 50 SG (*tifensulfuron-metil* 50%) 12 g/l + Leopard 5 EC (*quizalofop-P-etil* 50 g/l) 0.7 l/ha postem (tank-mix);

V_4 – Dual Gold 960 EC (*S-metolachlor* 960 g/l) 1 l/ha + Pledge 50 WP (*flumioxazin* 50%) 90 g/ha preem + Basagran Forte (*bentazon* 480 g/l + *wettol* 150 g/l) 2 l/ha + Leopard 5 EC (*quizalofop-P-etil* 50 g/l) 0.7 l/ha postem (tank-mix).

Size of experimental plots is 100 m², distance between rows is 12.5 cm, width of the sole for the herbicided variant is 6 m, lot width of 24 m, lot length of 50 m, area of a variant with 3 repetitions is 300 m² and the lot area of 1,200 m². The previous plant for the soybean crop was maize. Determining

Tab. 1. List of homologated herbicides for application in soybean crop

No. item	HERBICIDE (commercial product)	The content of herbicide's active compounds	Combated weeds	Application phases	The dose of commercial product	G. T.
0	1	2	3	4	5	6
A. Herbicide treatments applied ppi/pre-emergent						
1	ACETOCOLOR SUPER	<i>acetoclor 840g/l + antidot</i>	Monocotyledonous and some dicotyledonous weeds	ppi / pre-emergent	1.75-2.5 l/ha	Xi
2	GUARDIAN	<i>acetoclor 820g/l</i>	Annual monocotyledonous weeds <i>Setaria</i> , <i>Echinochloa</i> , <i>Digitaria</i>	ppi / pre-emergent	1.75-2.5 /ha	Xi
3	RELAY	<i>acetoclor 900g/l</i>	Annual monocotyledonous and dicotyledonous weeds	ppi / pre-emergent	1.7-2.2 l/ha	Xi
4	TORPEDO 90EC	<i>acetoclor 900g/l</i>	Annual monocotyledonous weeds	ppi / pre-emergent	1.7-2.2 l/ha	Xn
5	TROPHY SUPER	<i>acetoclor 840g/l</i>	Annual monocotyledonous weeds <i>Echinochloa</i> , <i>Setaria</i> , <i>Digitaria</i> ,	ppi / pre-emergent	1.8-2.4 l/ha	Xi
6	DUAL GOLD 960EC	<i>S-metolaclo 960g/l</i>	Monocotyledonous and some dicotyledonous weeds (not together with Pledge)	ppi / pre-emergent	1.0-1.5 l/ha	Xi
7	FRONTIER FORTE	<i>dimetenamid 720g/l</i>	Annual monocotyledonous and some dicotyledonous weeds	ppi / pre-emergent	0.8-1.4 l/ha	Xn
8	PROPONIT 720EC	<i>propisoclor 720g/l</i>	Annual monocotyledonous and some dicotyledonous weeds	ppi / pre-emergent	2-3 l/ha	Xi
9	STOMP 330EC	<i>pendimetalin 330g/l</i>	Annual monocotyledonous and some partial dicotyledonous weeds	ppi / pre-emergent	4-5 l/ha	Xn
10	SURDONE	metribuzin 700 g/kg	Annual monocotyledonous and some dicotyledonous weeds	pre-emergent	0.25-0.5 kg/ha	Xn
11	PLEDGE 50WP	<i>flumioxazin 50%</i>	Annual dicotyledonous weeds (residual pellicular)	pre-emergent	90 g/ha	Xi
B. Herbicide treatments applied postemergence						
12	AGIL 100EC	<i>propaquizafop 100g/l</i>	Annual monocotyledonous weeds, <i>Sorghum</i>	post-emergent	0.8-1.5 l/ha	Xi
13	ANACONDA	<i>quizalofop-p-etil 50g/l</i>	<i>Sorghum</i> from rhizomes	post-emergent	1.5-2 l/ha	Xn
14	ARAMO 50EC	<i>tepraloxidim 50g/l</i>	Annual monocotyledonous weeds, <i>Sorghum</i>	post-emergent	1-2 l/ha	Xn
15	ELEGANT 05EC	<i>quizalofop-p-etil 50g/l</i>	Annual monocotyledonous weeds <i>Setaria</i> , <i>Echinochloua</i> , <i>Sorghum</i> from seeds	post-emergent	0.75 l/ha	Xn
16	FOCUS ULTRA	<i>cicloxidim 100g/l</i>	<i>Sorghum</i> from rhizomes	post-emergent	3-4 l/ha	Xn
17	FURORE SUPER 75EW	<i>fenoxaprop-P-etil 75g/l</i>	<i>Sorghum</i> from rhizomes	post-emergent	3.5 l/ha	Xi
18	KILLER SUPER 5EC	<i>quizalofop-P-etil 50 g/l</i>	Annual monocotyledonous weeds, <i>Sorghum</i>	post-emergent	0.75-2 l/ha	Xi
19	LEOPARD 5EC	<i>quizalofop-P-etil 50g/l</i>	Annual monocotyledonous weeds, <i>Sorghum</i>	post-emergent	0.7-2 l/ha	Xi
20	PANTERA 40EC	<i>quizalofop-P-etil 40g/l</i>	Annual monocotyledonous weeds, <i>Sorghum</i>	post-emergent	0.75-2 l/ha	Xn
21	SELECT SUPER	<i>cletodim 120g/l</i>	Annual monocotyledonous weeds, <i>Sorghum</i>	post-emergent	0.6-2 l/ha	Xi
22	TARGA SUPER	<i>quizalofop-P-etil 50 g/l</i>	Annual monocotyledonous weeds, <i>Sorghum</i>	post-emergent	1-2.5 l/ha	Xi
23	TIGER P	<i>fluazifop-P-butyl 150g/l</i>	Annual monocotyledonous weeds, <i>Setaria</i> , <i>Echinochloa</i> , <i>Digitaria</i> , <i>Sorghum</i>	post-emergent	0.8-1.3 l/ha	Xi
24	PULSAR 40SL	<i>Imazamox 40g/l</i>	Annual monocotyledonous and dicotyledonous weeds (including <i>Abutilon</i> , <i>Solanum</i> , <i>Xantium</i> , <i>Datura</i>)	early post-emergent	0.75-1 l/ha	Xi
25	HARMONY 50SG	<i>tifensulfuron-metil 50%</i>	Annual dicotyledonous weeds (excluding <i>Solanum</i> and <i>Datura</i>)	post-emergent	12 g/ha+0.1% Trend	Xi
26	BASAGRAN FORTE	<i>bentazon 480 g/l wettol 150g/l</i>	Annual and perennial dicotyledonous weeds (<i>Convolvulus</i> , <i>Cirsium</i>)	post-emergent	2-2.5 l/ha	Xi

the degree of weeding was done with the metric frame using the numerical method.

RESULTS AND DISCUSSIONS

The recommended strategy for the control of weeds in soybean culture contains the following:

1. Planning an integrated system for weed control in crop rotations of 4-5 years. Introducing soybean crop in rotation with straw cereals and maize is very important, given that perennial dicotyledonous weeds (*Cirsium*, *Sonchus*, *Convolvulus*, *Lathyrus* etc.) are very difficult to control in the soybean culture, while herbicides applied to maize and straw cereals control them, and in addition to that, can obviously reduce the overall weeding of the field.

2. Improving the management of plant cultivation and reintroduction of „better agrotechnical practices“. Positioning the cultures after preceding ones that leave the ground clear of weeds, crop rotation and herbicides, correct soil tillage, control of weeds that arise primarily at seedbed preparation and choosing the optimal sowing period, contributes to a significant extent to the reduction of weed infestation in the soybean crop.

3. The use of the herbicides based on glyphosate (Roundup, Dominator, Cosmic, Clinic, Sikosto, Sanglypho, Glyfos, Glifotim etc.), applied before, during or after sowing, but before the sprung of

the soybean plants, at a dosage of 3-4 (5) l/ha. Not less than 4 years the sprayed soles will be free of perennial weeds, until a new re-infestation. It is recommended that these herbicides to be applied after rain or in the evening (when leaves are turgid) and not during extreme heat. To fully absorb and translocate in the underground parts is required that after application, 5-6 hours, it does not rain. Since the glyphosate is absorbed only by the leaves, the one that reaches the ground is lost therefore it must be applied by spraying weeds with as small amounts of water as possible. With conventional sprayer devices can be applied the recommended doses in 100-150 l/ha. It can be associated tank-mix 2.4D - 0.5 l/ha (7 days) with 1 l/ha (30 days before the sowing of the soybean crop), in order to increase the efficiency of the dicotyledonous weed control. For the control of residual weeds, tank-mix may be associated with Surdone or Pledge 50WP.

4. Application of herbicides according to the weed spectrum, at optimal doses and time periods. In order to maintain soybean cultures clean of weeds, it is necessary, in general, to apply two chemical treatments, the first ppi/pre-emergent spraying for some annual dicotyledonous and monocotyledonous weeds (point A in Table 1) and the 2nd post-emergence treatment for dicotyledonous weeds. If on vegetation exists infestations

Tab. 2. Influence of herbicide variant on the weed growth of culture soybean in flowering phase

Weeds	No. weeds/m ²			
	V ₁ – Frontier Forte & Surdone & Pulsar & Stratos Ultra	V ₂ – Stomp & Surdone & Basagran Forte & Agil	V ₃ – Surdone & Harmony & Leopard	V ₄ – Dual Gold & Pledge & Basagran Forte & Leopard
<i>Echinochloa crus-galli</i>	-	-	4.1	3.2
<i>Setaria glauca</i>	-	1.2	3.1	2.1
<i>Chenopodium album</i>	-	2.1	2.2	1.1
<i>Hibiscus trionum</i>	2.2	1.1	2.5	-
<i>Xanthium strumarium</i>	-	-	1.2	-
<i>Euphorbia helioscopia</i>	-	1.2	-	-
<i>Convolvulus arvensis</i>	2.2	3.1	2.1	3.1
<i>Cirsium arvense</i>	-	3.2	-	-
<i>Lathyrus tuberosus</i>	3.1	4.1	2.1	3.1
Total	7.5	16	17.3	12.6
Soybean plant height, cm	34	38	36	39
Density of the soybean, plants/m ²	90	84	97	89

both with annual or perennial monocotyledonous weeds, good results are obtained by associating two complementary herbicides, which combat both monocotyledonous and dicotyledonous weeds (point B in Table 1). Depending on the range of weed-infested crop of soybean, may be applied the homologated herbicides shown in Table 1.

The experimental variants were significantly reduced weeding soybean crop. During blossoming culture of soybean (16/06/2014) culture was at a normal density and height (Table 2). The lowest degree of weed, only 7.5 weed/m², was determined in V₁-Frontier Forte & Surdone & Pulsar & Stratos Ultra.

CONCLUSION

Application of ppi or pre-emergent herbicides is conditioned by the conditions of humidity. Thus, while drought conditions is recommended their incorporation at 2-4 cm depth before sowing, and while sufficient humidity conditions they should be applied pre-emergent at 1-2 days after sowing.

Treatments shall be made on vegetation when the soybean plants have 2-3 pairs of three - folioled leaves and dicotyledonous weeds are at a maximum of 3 to 4 leaf stage. Monocotyledonous weed control treatments will be done in the phase of 2-3 leaflets until the twinning (especially *Echinochloa*). In general, if the maximum weed infestation is passed and the optimal phase is surpassed (of 4 leaflets), the application of maximum approved dose is recommended. Taking into account the gradual emergence of the weeds (especially *Xanthium*), treatments can be done sequentially, in two stages but in lower doses then when only for a single application treatment. Also, to increase the spectrum of control it can be applied concomitant treatments (tank-mix): Basagran Forte + Select Super (2+0.6). Targa Super must not be applied together with Basagran. During post-emergence application of treatments is contraindicated to use mechanical or manual hoeing one week before treatment and two weeks after the treatment, in order not to interrupt the translocation of the herbicide.

Weed control in soybean crop ensures and enhances the return on investment for the used technology elements: fertilization, genetic potential of varieties, irrigation and exploitation of environmental resources.

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