Pestic. Phytomed. (Belgrade), 27(1), 2012, 69–75
DOI: 10.2298/PIF1201069D

UDC: 632.954:633.2
Scientific paper

Selectivity of Some Herbicides to Cocksfoot (*Dactylis glomerata* L.), Grown for Seed Production

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Received: August 3, 2011
Accepted: February 20, 2012

SUMMARY

The study was conducted to determine selectivity of some herbicides to cocksfoot (*Dactylis glomerata* L.), and their influence on the seed production, during the years 2008-2010. The trial was set on the experimental field of the Institute of Forage Crops – Pleven, on slightly leached chernozem. As a result of the research the following was found: herbicides Arat (500 g/l dicamba + 250 g/l tritosulfuron) at the dose of 100 ml/ha, Korida 75 VDG (750 g/kg tribenuron-methyl) – 15 g/ha and Cambio SL (320 g/l bentazon + 90 g/l dicamba) – 1250 ml/ha and Grasp 25SK (250 g/l tralkoxyidim) + Atplus at rate of 1000 + 1000 ml/ha had high selectivity to cocksfoot, applied at 2-4 leaf stage during establishing year of the stand, and until the stage of the beginning of shooting up in seed production year.

Herbicide Topik 080EK (80 g/l clodinofop – propargyl + antidote) at rate of 300 ml/ha, showed phytotoxic effect to *D. glomerata* and caused the reduction of seed and dry biomass productivity.

Keywords: Dactylis; Seed; Herbicides; Pesticide selectivity

INTRODUCTION

Cocksfoot (*Dactylis glomerata* L.) is a long-lived perennial grass, widely spread in the temperate zone. It has good regrowth characteristics and adaptability to various environmental conditions. It is widely distributed in most European countries (including Bulgaria), North America such as the USA and Canada, South America, Australia, New Zealand, and Asia (Boller et al., 2010). As a valuable component of sown pastures and source of quality forage for herbivores in ecological livestock production systems, cocksfoot posses high value of biological and agricultural characteristics. It shows heat and drought tolerance under Mediterranean climatic conditions but is not tolerant to water logging and wet soils and only moderately winter hardy. Cocksfoot is used for hay, silage, and grazing, and is suitable for mixed sowing with alfalfa or red clover and white clover. The main advantage of this species is greater forge production during summer compared to other forage grasses. In Institute of Forage Crop – Pleven the first and the only Bulgarian variety Dabrava was developed, with an average seed yield of 700 to 900 kg/ha (Tomov, 1987).

Efficient weed control has an important role in establishment and growth of highly productive seed production stand of perennial grasses, as well as cocksfoot.

According to Oerke (2005) there is a great need for applied studies of weeds and their control particularly because weeds reduce crop yield to a greater extent compared to other harmful organisms (diseases and pest insects). It is necessary to integrate researches of the whole spectrum, whereabout all elements would contribute to improvement of weed control (Moss, 2008).

Specific biological characteristic of *D. glomerata* is slow pace of growth and development first two – three months after sowing. That is why the elimination of the competition of the weeds during establishing year is important for persistence and productivity of perennial grasses (Dimitrova, 1995, 2003; Dong et al., 2005; Dimitrova and Katova, 2011).

In spite of limited number of studies on this crop, the selective and efficient herbicides were found by some authors (Dimitrova, 1989, 1999, 2007; Lepiēs et al., 1999, 2000) to control weed species. Nevertheless, in last decades chemical control methods are widely used. Use of herbicides for a long period on the same area leads to compensation changes in weed species composition. Some authors reported the problem of weed resistance to herbicides in their studies (Gressel, 2002; Heap, 2007; Neve, 2007).

Present demands with ecological and economical aspect, the concurrence in pesticide market, need research herbicides with new active substances and new formulations which will lead to improvement of the chemical methods to weed control.

The aim of the study was to determine which selective herbicides can be used in cocksfoot and their influence on seed and dry biomass productivity.

MATERIAL AND METHODS

Using uniform methodology during the years 2008-2010 on the experimental field of the Institute of Forage Crops (IFC) in Pleven a study with cocksfoot and perennial ryegrass was conducted (Dimitrova and Katova, 2011). The soil type was leached medium deep chernozem, poor to medium in humus, medium sandy clay. The humus horizon reached 60 to 65 cm. When laying out the trails the following content was found in soil samples: mobile forms of nitrogen (50-87 mg/1000 g), phosphorus and potassium 3-9.3 and 20-34 mg/100 g respectively, pH_{KCl} 5.4-6.8, and humus 2.6%. The soil supply of hydrolizable nitrogen was medium to good, of phosphorus – poor to medium and of potassium – medium to very good. The soil had slightly acidic to neutral reaction and low humus content. These soil conditions are favorable for cocksfoot growth and development. The experiment was established by the long plot method in three replications with the size of the harvested plot – 5 m^2, precipitation in mm is presented in Table 1.

The sowing was done in spring (March) with cocksfoot Bulgarian variety Dabrava, developed in IFC, inter-row distance 36 cm and sowing rate – 20 kg/ha. Fertilizing was conducted with P_2O_5 – 100 kg/ha and N – 120 kg/ha (½ in spring + ½ in autumn – each year).

Table 1. Precipitation in mm for the years 2008-2010

Year \ Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2008	62.2	3.2	20.8	78.1	57.8	31.1	31.5	17.1	65.3	62.3	9.3	30.4
2009	39.9	98.7	40.1	22.3	31.5	58.4	95.5	35.0	60.6	56.4	10.7	63.9
2010	42.2	74.1	78.8	60.5	73.7	85.1	110.0	22.8	23.6	-	-	-

The manual removal of the weed was done during the whole growing season to eliminate their negative influence on crop and to measure only the effect of the herbicides.

The subject of the study were systemic foliar herbicides, which are registered in our country for cereal, crops (www.videnovisin.com, 2009, 2010, 2011). Concerning the spectrum of activity they control annual and some perennial broadleaf weeds including herbicide resistant weeds: Arat (500 g/kg dicamba + 250 g/kg tritosulfuron), Korida 75VDG (750 g/kg tribenuron-methyl), Cambio SL (320 g/l bentazone + 90 g/l dicamba); and the group of annual grass weeds, including wild oat (*Avena fatua* L.): Grasp 25SK (250 g/l tralkoxydim) + Atplus 463 and Topik 080EK (80 g/l clodinafop-propargyl + antidote). Trial treatments and herbicide application rates are shown in Table 2.

Table 2. Variants of the trail

Variant	Dose-commercial product ml (g)/ ha	Dose-active ingredient ml (g)/ ha
V_1 – Check – untreated	-	-
V_2 – Arat (500 g/l dicamba+250 g/l tritosulfuron)	100	75
V_3 – Korida 75VDG (750 g/kg tribenuron-methyl)	15	11
V_4 – Cambio SL (320 g/l bentazon + 90 g/l dicamba)	1250	513
V_5 – Grasp 25SK (250 g/l tralkoxydim) + Atplus	1000 + 1000	250 + 1000
V_6 – Topik 080EK (80 g/l clodinafop-propargyl + antidote)	300	24

The treatment was conducted with 400 l/ha of spray liquid by hand sprayer "Mathaby", conic nozzle, pressure – P max 3 bar, V max 1.56 l, Q max 0.6 l/ min. At the time of the treatment, plants were at 2-4 leaf stage during establishing year of the stand, and from spring growth until the stage of the beginning of shooting up in seed production year.

The cocksfoot has a winter type of development and generative tillers are formed during the second year of the stand. For this reason, seeds were harvested from second to third year of the crop growing.

The following characteristics were observed: phytotoxicity of the herbicides to the crop 7, 14 and 30 days after treatment (DAT) and during seed harvesting – by logarithmic scale from 1 to 9 score (score 1 – no damage and score 9 – the crop is completely destroyed); structural analysis of the elements of the productivity of 60 generative tillers for each treatment; number of generative tillers per m^2; seed yield and dry biomass yield with statistical method of dispersion data analysis; seed qualities (1000 seed weight – TSW, germination energy and germination).

RESULTS AND DISCUSSION

Cocksfoot, which is not the exception from the group of perennial grasses, has slow growth and development during establishing year of the stand. Rainfalls immediately after sowing at quantity of 20.8 mm and further rainfalls of 109.7 mm made favorable conditions for very well distributed stand (Table 1). The results from the evaluation of the selectivity by logarithmic scale (Table 3) showed that herbicides for control of dicotyledonous weeds (Arat, Korida 75VDG and Cambio SL) at applied doses (100 ml/ha, 15 g/ha and 1250 ml/ha) did not cause phytotoxic effect to cocksfoot during the first year, as well as in seed production year.

Table 3. Selectivity of the herbicides to cocksfoot (*Dactylis glomerata* L.)

Herbicide	Score of damage (according to EWRS*)					
	Days after treatment					
	7		14		30	
	A**	B***	A	B	A	B
Arat	1	1	1	1	1	1
Korida 75VDG	1	1	1	1	1	1
Cambio SL	1	1	1	1	1	1
Grasp 25SK	1	1	1	1	1	1
Topik 080EK	4	3	6	5	6	7

* EWRS – logarithmic scale (1-9) – score 1 – no damage; score 9 – the crop is completely destroyed

** A – during the establishing year of the stand

*** B – during seed production year

Table 4. Influence of the herbicides on growth and development of *D. glomerata* during harvesting of I-st cut in the establishing year of the sward

Variant*	Characters		
	Vegetative stems, number/m^2	Stem height, cm	Fresh weight of the stems g/m^2
V_1	2422	33.3	2384
V_2	2447	33.5	2369
V_3	2385	32.8	2327
V_4	2312	33.0	2299
V_5	2359	32.9	2310
V_6	1213	23.5	988
Average	**2190**	**31.5**	**2113**
min	**1213**	**23.5**	**988**
max	**2447**	**33.5**	**2384**

* Variant: The same as in Table 1

There are differences in behavior of grass weed control herbicides. Grasp 25SK + Atplus at doses of 1000 + 1000 ml/ha are highly selective, while Topik 080EK at dose of 300 ml/ha caused phytotoxicity to *D. glomerata*.

During the first seven days after treatment there was a phytotoxic effect – mild to moderate chlorosis (score 4), while 14 and 30 DAT damages were serious (score 6), expressed as necrosis of the leaves and inhibition. In seed production year 7 DAT the effect of mild inhibition was found (score 3), increasing to moderate and delay of heading (score 5) 14-DAT. 30 DAT damages were much more serious (score 7), expressed in inhibition, necrotic leaves and weak heading.

Data in Table 4 confirmed the observations with results when harvested the growth for forage during establishing year of the stand. As it can be seen from the results of the treatment with herbicides for control of dicotyledonous weeds (V_2, V_3 and V_4), the values of the characteristics number and fresh weight of vegetative stems per unit area and their height were close to these from untreated check (V_1).

When the stand was treated with Grasp 25 SK (V_5), there were insignificant deviations of the same characteristics, which is evidence for the selectivity of this herbicide to *D. glomerata*. As the result of expressed phytotoxicity of the other herbicide used for control of the grass weeds – Topik 080EK (V_6), there was strong reduction of parameters, characterized by vegetative stems development. Concerning the number and weight of the stems per m^2 it amounted 50% and 59% respectively, and their height 29%.

Interesting results were obtained for the effect of herbicides on seed productivity of this crop (Table 5). In spite of higher seed yield during second seed harvesting year (from 329 kg/ha to 801 kg/ha) compared to the first one (from 284 to 753 kg/ha) the tendency between different variants was kept. The values of this character for the stands treated with selective herbicides (V_2, V_3, V_4, V_5) were close to these from untreated check (V_1), and differences between them were not statistically significant.

As a result of expressed phytotoxicity of the herbicide Topik 080EK (V_6) the seed yield was lowered by 61.9 to 67.1% with very good negative significance of differences compared to the check (V_1). Topik 080EK is not suitable for application in seed production stands of *D. glomerata* for control of grass weed (Dimitrova, 2007).

Table 5. Influence of the herbicides on seed productivity of *D. glomerata*

Variant*	Seeds					
	2009		2010		Average 2009-2010	
	kg/ha	% V_1	kg/ha	% V_1	kg/ha	% V_1
V_1	746	100.0	792	100.0	76.9	100.0
V_2	740	99.2	797	100.6	76.9	100.0
V_3	748	100.3	786	99.2	76.7	99.7
V_4	739	99.1	798	100.8	76.9	100.0
V_5	753	100.9	801	101.1	77.7	101.0
V_6	284	38.1	329	41.5	30.7	39.9
GD $P_{5\%}$	**263**		**289**		**18.3**	
$P_{1\%}$	**375**		**418**		**25.9**	
$P_{0.1\%}$	**542**		**605**		**37.6**	

* Variant: The same as in Table 1

Table 6. Elements of seed productivity of *D. glomerata*

Variant*	Generative stems				Length of the panicle, cm		Thousand seed weight, g	
	number/m^2		height, cm					
	2009	2010	2009	2010	2009	2010	2009	2010
V_1	614	877	105.8	122.4	18.6	12.6	1.12	0.96
V_2	604	874	106.0	121.0	19.0	12.7	1.16	0.98
V_3	620	878	104.4	122.0	18.8	12.0	1.13	0.95
V_4	608	881	106.0	122.9	18.4	12.6	1.12	0.96
V_5	623	877	105.2	121.3	19.1	13.0	1.10	0.92
V_6	232	362	75.8	80.2	12.2	6.4	1.15	0.99
Average	**550**	**792**	**100.5**	**115.0**	**17.7**	**11.6**	**1.13**	**0.96**
min	**232**	**362**	**75.8**	**80.2**	**12.2**	**6.4**	**1.10**	**0.92**
max	**623**	**881**	**106**	**122.9**	**19.1**	**13.0**	**1.16**	**0.99**

* Variant: The same as in Table 1

Table 7. Dry biomass productivity of *D. glomerata*

Variant*	Dry biomass							
	2008		2009		2010		Average 2008/2010	
	kg/ha	% V_1	kg/ha	% V_1	kg/ha	% V_1	kg/ha	% V_1
V_1	4580	100	10250	100	12180	100	9000	100
V_2	4420	97	10190	99	12100	99	8900	99
V_3	4550	99	10190	99	12090	99	8940	99
V_4	4820	105	10170	99	12200	100	9060	101
V_5	4370	95	10290	100	12260	101	8970	100
V_6	1770	39	3930	38	8270	68	4660	52
GD $P_{5\%}$	**308.8**		**129.6**		**207.2**		**162.6**	
$P_{1\%}$	**427.0**		**184.4**		**294.7**		**231.3**	
$P_{0,1\%}$	**590.2**		**266.9**		**426.6**		**334.9**	

* Variant: The same as in Table 1

Data analyses concerning the elements of the seed productivity showed relationship with the previous character (Table 6). The selective herbicides did not have negative effect on the density of generative tillers in stands, their height and length of panicles. As a result of expressed phytotoxicity of Topik 080EK (V_6), formed generative tillers were significantly lower, 400 and 515 tillers/m^2, respectively. For that reason significant reduction of the values for the height of generative tillers (30-42.2 cm) and length of panicle (6.2-6.4 cm) was found. According to the 1000 seed weight there were no regular differences and its values ranged from 1.10 to 1.16 g for the first and from 0.92 to 0.99 g for the second year. These data corresponded with variety description by the author (Tomov, 1987).

From seed production stands of cocksfoot *D. glomerata* significant quantity of additional production of dry biomass was obtained, formed from crop residues and aftermath (Table 7). The formed yield from the stands treated with selective herbicides (V_1, V_3, V_4, V_5) during the experimental period was from 8900 to 9060 kg/ha on average without evident differences compared to untreated check (V_1). Similarly, negative influence of inhibiting effect of the herbicide Topik 080EK was

also observed for this character and dry biomass yield was 48% lower compared to the check. This was confirmed with a very high negative significance of the difference for the yield.

CONCLUSIONS

Herbicides Arat (500 g/l dicamba + 250 g/l tritosulfuron) at the dose of 100 ml/ha, Korida 75 VDG (750 g/kg tribenuron-methyl) – 15 g/ha and Cambio SL (320 g/l bentazon + 90 g/l dicamba) – 1250 ml/ha and Grasp 25SK (250 g/l tralkoxyidim) + Atplus at rate of 1000 + 1000 ml/ha had high selectivity to cocksfoot, applied at 2-4 leaf stage during establishing year of the stand and until the stage of the beginning of shooting up in seed production year.

Herbicide Topik 080EK (80 g/l clodinofop – propargyl + antidote) at rate of 300 ml/ha showed phytotoxic effect to *D. glomerata* and caused the reduction of seed and dry biomass productivity.

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Selektivnost nekih herbicida prema ježevici (*Dactylis glomerata* L.) gajenoj za proizvodnju semena

REZIME

U periodu 2008-2010. godine ispitivana je selektivnost nekih herbicida prema gajenoj ježevici (*Dactylis glomerata* L.) i njihov uticaj na produkciju semena. Ogled je postavljen na eksperimentalnim površinama Institute of Forage Crops, Plovdiv, na blago ispranom černozemu. Na osnovu izvedenih istraživanja konstatovano je sledeće: herbicidi Arat (550 g/l dikamba + 250 g/l tritosulfuron) primenjen u količini 100 ml/ha, Korida 75 VDG (750 g/kg tribenuron-metil) – 15 g/ha, Cambio SL (320 g/l bentazon + 90 g/l dikamba) – 1250 ml/ha i Grasp 25SK (250 g/l tralkoksidim) + Atplus u količini 1000 + 1000 ml/ha, primenjeni u fazi 2-4 lista u godini zasnivanja ježevice i do početka vlatanja u godini proizvodnje semena, pokazali su visok stepen selektivnosti prema ježevici.

Herbicid Topik 080EK (80 g/l klodinofop-propargil + antidot) u količini primene 300 ml/ha, izazvao je fototoksične efekte na *D. glomerata* koji su se odrazili na smanjenu produkciju semena i nižu produktivnost suve biomase.

Ključne reči: Dactylis; seme; herbicidi; selektivnost pesticida