Pak J. Weed Sci. Res. 12(4): 299-306, 2006

POSTEMERGENCE WEED CONTROL IN SEEDLING ALFALFA (*Medicago sativa* L.) WITH IMAZAMOX

Tasko Kostov and Zvonko Pacanoski[1]

ABSTRACT

Field trails were conducted during 2005 and 2006 in two localities. The objectives of the study was to evaluate the suitability of imazamox to provide selective control of weeds in seedling alfalfa. The imazamox selectivity and influence on alfalfa dry matter yield were also evaluated. Weed population in the trials was composed of 17 and 21 weed species in Skopje and St. Nikole region, respectively. The most prevailing weeds in both region were: Sorghum halepense, Setaria verticillata, Veronica hederifolia, Chenopodium album, Alopecurus mysuroides, and Datura stramonium. Total weediness in Skopje region was 340, 6 plants m^{-2}, and in St. Nikole region 62, 2 plants per 1 m^2. Imazamox at 1 L ha^{-1} and 1.2 L ha^{-1} applied at the 3-4 trifoliate stage showed high selectivity and herbicidal efficacy reaching 96.2-99.0% in both regions. Herbicidal treatments in both regions significantly increased alfalfa dry matter yield in comparison with the weedy check.

Key words: Herbicides, Weeds, Seedling alfalfa

INTRODUCTION

Imazamox belongs to the imidazolinone class of herbicides. These herbicides inhibit the enzymatic activity of acetohydroxyacid synthase (AHAS), the first enzyme in the pathway for the synthesis of the branched-chain amino acids (valine, leucine and isoleucine) [(Shaner *et al.*, 1984)]. Imazamox is registrated for weed control in many crops including alfalfa (Rethwisch and Nelson, 2000; Dimitrova and Milanova, 2006), sainfoin, birdsfoot trefoil (Dimitrova and Milanova, 2006), soybean (Nelson and Renner, 1998), pea (Harvey *et al.*, 1995; Blackshaw, 1998;Yenish and Eaton, 2002; Ball *et al.*, 2003) and herbicide-resistant wheat (Ball *et al.*, 1999;2003) and sunflower (Massinga *et al.*, 2005). Imazamox controls a broad spectrum of broadleaf and grass weeds: *Chenopodium album* L. and *Amaranthus retroflexus* L. (Blackshaw, 1998), *Sonchus oleraceus* L. (Rethwisch and Nelson, 2000), *Aegilops cylindrica* Host (Ball *et al.*, 1999), *Bromus tectorum* L. (Ball and Walenta, 1997; Gamroth *et al.*, 1997; Neider and Thill, 1997; Stougaard *et al.*, 2004), *Avena fatua* L. (Belles and Thill, 1998; Rethwisch and Nelson, 2000), *Lolium multiflorum* Lam. (Brewster *et al.*, 1997), and others (Gamroth *et al*. 1997;Ogg *et al.*, 2001). Imazamox has many advantages as compare to imazethapyr. Numerous studies indicate that soil persistence of imazamox is less than that of imazatapyr (Anonymous, 1994; 2002; O'Sullivan *et al.*, 1998). Because of that, some growers are reluctant to use imazethapyr because its soil persistence is sufficient to injure some rotational crops planted 1 year or more later (Moyer and Esau, 1996). Further, imazethapyr controls a similar spectrum of broadleaf weeds as imazamox, but

[1]Faculty for Agricultural Sciences and Food, 1000 Skopje, R. Macedonia
E-mail:zvonkop@zf.ukim.edu.mk

fewer grassy weeds, and finally, the interest for application of reduced rates of imazamox (active ingredient is half that of imazathapyr) is in favour of the farmers and environment.

Taking into consideration all above facts, the objective of this study was to determine efficacy and selectivity of imazamox in seedling alfalfa (*Medicago sativa* L.).

MATERIALS AND METHODS

The field trials were conducted during 2005 and 2006 in Skopje and St. Nikole region Macedonia on alluvial soil and slightly leached chernozem, respectively. Design of trials was randomized complete block with four replicates and harvested plot size of 25 m^2. The field trials were carried out with alfalfa variety "Debarska". Standard agronomic practices were followed during the both years of trails. The following treatments were included in the study (Table-1).

Table-1. Detail of Treatments in the experiment.

Treatment	Active Ingredient (g L^{-1})	Common Names	Rate (L ha^{-1})
Weedy check	-------	-------	-------
Pulsar-40	40	imazamox	1.0
Pulsar-40	40	imazamox	1.2
Pivot 100-E	100	imazethapyr	1.0

The herbicidal treatments were applied in the 3-4 trifoliate leaf stage on 15th May, 2005, and 18th May, 2006, in Skopje region, and 9th May, 2005, and 13th May, 2006, in St. Nikole region, respectively, with a CO_2-pressurized backpack sprayer with 400 l ha^{-1} water. Data were recorded on the degree of weed density (by quantity method-number per m^2), herbicidal efficacy, selectivity (by EWRS scale), and dry matter yield (kg ha^{-1}). Herbicide efficacy was estimated 30 DAT by the weed plants counting. Coefficient of herbicide efficacy was calculated by equitation:

$$C_E = \frac{Wc - W_T}{Wc} \times 100$$

where:
C_E coefficient of efficacy
W_C- number of weeds in the check plots
W_T- number of weeds in the treated plots

Visible injury ratings were based on scale of EWRS (1 = 0% mortality and 9 = 100% mortality). The alfalfa at both locations was harvested four times, but only yield of the first cutting is shown because effects of herbicides were not significant in late harvests. First harvest forage in the both years was harvested when alfalfa was in the early bloom stage. Fresh weight was determined, and 500 g forage samples from each plot were dried at 50°C and reweighed to determine dry alfalfa yield. The data were finally subjected to statistical analysis applying LSD-test.

RESULTS AND DISCUSSION

Weed population

The weed population in the experiment was consisted mainly of annual spring and summer weeds. and some winter and perennials weeds, typically for seedling alfalfa. In the Skopje region the weediness was relatively higher in both years with average 340.6 plants m^{-2}. The most prevailing among the 17 weed species in this region were: *S. halepense* (132.8 plants m^{-2}), *S. verticillata* (55.8 plants m^{-2}), *V. hederifolia* (48.0 plants m^{-2}), *C. album* (34.5 plants m^{-2}) and *A. myosuroides* (29.0 plants m^{-2}) [Table-2]. Although in the St. Nikole region the weed population consisted of 21 weed species, the weediness was relatively lower in both years with average of 62.2 plants m^{-2}. Dominant weeds were *S. verticillata* (13.3 plants m^{-2}), *D. stramonium* (10.3 plants m^{-2}), *C. album* and *L. multiflorum* (8.5 plants m^{-2}) [Table- 2].

Table- 2. Weed population (No m^2) in the experiment (average for two years)

Weed species	Skopje region	St. Nikole region
Sorghum halepense	132.8	
Setaria verticilata	55.8	13.3
Veronica hederifolia	48.0	-
Chenopodium album	34.5	8.5
Sinapis arvensis	23.5	1.0
Alopecurus myosuroides	29.0	-
Datura stramonium	-	10.3
Papaver rhoeas	8.5	-
Lolium multiflorum	-	8.5
Polygonum convolvulus	4.3	1.0
Amaranthus retroflexus	0.5	3.3
Solanum nigrum	0.5	2.5
Amaranthus blitoides	-	2.3
Delphinium orientale	-	2.0
Lepidium draba	-	1.0
Onopordum acanatum	-	1.0
Chondrila juncea	-	1.0
Xanthium italicum	-	1.0
Meliolotus officinalis	-	1.0
Sonchus asper	0.5	1.0
Capsella bursa-pastoris	1,0	-
Abutilon theophrasti	0.3	1.0
Chenopodium hybridum	0.3	1.0

Stellaria media	0.5	-
Xanthium spinosum	-	0.5
Caucalis latifolia	-	0 5
Salsola ruthenica	-	0.5
Plantago major	0.3	-
Artemisifolia vulgaris	0 3	-
Total weed species	17	21
Total weeds (No. m^{-2})	340.6	62.2

Herbicide efficacy

The absolute criterion for herbicide efficacy was taken as the percentage weeds that are controlled by any particular treatment From the data regarding herbicide efficacy presented in Table-3, we can see that all investigated herbicides had significant ($P < 0.01$) effect on weeds number per m^{-2}. Maximum weeds in both regions were recorded in weedy check plots (340.6 and 62.2, respectively), while minimum (3.3 and 1 3, respectively) were recorded in Pulsar-40 at high rate application. Efficacy of Pulsar-40 with regard to the weed number per m^{-2} was high in both regions and similar as standard herbicide Pivot 100-E Co-efficient of efficacy ranged from 96.2 to 99.0% in Skopje region, and 96.3 to 96 8% in St Nikole region, respectively. Similar findings were reported by Dimitrova and Milanova (2006), who stated that Pulsar-40 in combination with adjuvant Desh applied in early growing season of alfalfa, birdsfoot trefoil and sainfoin had high selectivity and herbicidal efficacy reaching 93-97% as compared to the with weedy check. Pulsar-40 at high rate application gave an excellent control of prevailing weeds in both regions, particularly problematic grassy weeds. *S. halepense*, *S. verticillata* and *A. myosuroides*. Coefficient of efficacy for both regions ranged from 97.7 to 100.0% (Table-4). Control of *A. cylindrica* with postemergence application of imazamox ranged from 61 to 97% when applied at 36 g ha^{-1} (Ball *et al.*, 1999). Blackshaw (1998) found that imazamox at 7 to 36 g ha^{-1} provided 90% reduction in *S. viridis*, *A. fatua*, *A. retroflexus* and *C. album* biomass. Harvey *et al.* (1995) similarly reported greater than 90% control of *C. album* with imazamox at 26 to 35 g ha^{-1}. Same results were obtained by Yenish and Eaton (2002). Nelson and Renner (1998) found that imazamox at 45 g ha^{-1} provided 90 and 88 to 90 % control of *C. album*, and 88 to 99% control of *S. faberi* in two locations Also, our observations showed complete control of the weeds that were at earlier stages of their development at the time of herbicide application. The weeds that were at a more advanced stage (*A. vulgaris* and *M. officinalis*) were not controlled by Pulsar-40 Actually, these species are not typical weeds for seedling alfalfa in these agro-ecological regions.

Taking into considerations the fact that imazamox possesses high selectivity to alfalfa, no visual injury was determined at both imazamox rates in both years and regions (Table-5). No visual injury was recorded in dry pea when imazamox was applied at an earlier growth stage (Yenish and Eaton, 2002).

Table-3. Effect of herbicidal treatments on weeds and herbicide efficacy (average for both years)

Treatments	Rate	Weed density m^{-2}		Coefficient of efficacy	
		Skopje region	St. Nikole region	Skopje region	St. Nikole region
Weedy check	-------	340.6	62.2	-------	-------
Pulsar-40	1,0 l/ha^{-1}	12.9**	1 5**	96.2	96.3
Pulsar-40	1,2 l/ha^{-1}	3.3**	1 3**	99 0	96.8
Pivot 100-E	1,0 l/ha^{-1}	4.3**	1.5**	98 7	96.3
LSD 0.01		*45.43*	*17 59*		

(**) Significant level p<0.01 NS (non significant)

Table 4: Control of prevalent weeds in both region (average for both years)

Treatments	Rate	Weed control						
		SORHA	SETVE	LOLMU	ALOMY	CHEAL	DATST	VERHE
Weedy check	-------	-------	-------	-------	-------	-------	-------	-------
Pulsar-40	1,0 lha^{-1}	93.4	100.0	100.0	92.1	95.6	100.0	100 0
Pulsar-40	1,2 lha^{-1}	97 7	100 0	100 0	100 0	98.3	100.0	100 0
Pivot 100-E	1,0 lha^{-1}	97.7	100.0	100 0	100.0	95.6	100 0	100 0

Abbreviations: DAT-days after treatment; SORHA-*Sorghum halepense*; SETVE-*Setaria verticilata* LOLMU-*Lolium multiflorum* ALOMY-*Alopecurus myosuroides*; CHEAL-*Chenopodium album*, DATST-*Datura stramonium*, VERHE-*Veronica hederifolia*

Dry Matter Yield (kg ha^{-1})

The removal of the competitive effect of the weeds led in an increase of the participation of the yield components of the alfalfa crop and as a result the dry matter production also increased. Herbicidal treatments in both regions had significant ($P < 0.01$) effect on dry matter yield (Table-5). In both regions the lowest dry matter yield was recorded in weedy check plots (1143 and 1914 kg ha^{-1}, respectively), while the highest dry matter yield in both regions (2891 and 2720 kg ha^{-1}, respectively) was recorded in Pulsar-40 (at high rate application) treated plots. Dimitrova and Milanova (2006) have reported a significant increase in alfalfa dry matter yield for 2 4 and 2.8 times, respectively with application of imazamox Soybean yield in wide- and narrow-row soybean treated with imazamox at 35 and 45 g/ha was equal to the hand-weeded control (Nelson and Renner 1998). Similar results were reported by Blackshaw (1998) who stated that pea yield comparable to that of the hand-weeded control was attained with 20 to 30 g/ha of imazamox .

Table-5. First-harvest dry matter yields (kg ha^{-1}) and crop injury (average for both years).

Treatments	Rate	Dry matter yield (kg ha^{-1})		Alfalfa injury (%)	
		Skopje region	St. Nikole region	Skopje region	St. Nikole region
Weedy check	-------	1143	1914	-------	-------
Pulsar-40	1,0 l/ha^{-1}	2795**	2668**	0	0
Pulsar-40	1,2 l/ha^{-1}	2891**	2720**	0	0
Pivot 100-E	1,0 l/ha^{-1}	2856**	2695**	0	0
LSD 0.05		*96.50*	*63.02*		
LSD 0.01		*138.64*	*90.55*		

(*) Significant level p<0.05 (**) Significant level p<0.01 NS (non significant)

REFERENCES CITED

Anonymous. 1994 : AC 299,263 Experimental Herbicide, Princeton NJ, American Cyanamid

Anonymous. 2002: New Herbicide for Alfalfa, Field Crops Report, University of California-Cooperative Extension http //cesanjoaquin ucdavis edu/newsletterfiles/Field_Crops_ Report_Newsletter1977 pdf.

Ball, D A. and D. L.Walenta. 1997. Jointed goatgrass and downy brome control in Imidazolinone resistant winter wheat. Western Soc. Weed Sci. (WSWS) Res.Prog. Rep. p 89.

Ball, D. A., F L Young, .and A G. Ogg (Jr.). 1999 Selective control of jointed goatgrass with imazamox in herbicide-resistant wheat. Weed Tech. 13 (1):77–82.

Ball, D. A., J P Yenish, and T. Alby. 2003. Effect of imazamox soil persistence on dryland rotational crops Weed Tech. 17 (1): 161-165.

Belles, W. S. and D. C. Thill, 1998. Weed Control in imidazolinone-resistant winter wheat. WSWS Res. Prog. Rep. 146 p.

Blackshaw. R E. 1998. Postemergence weed control in pea (*Pisum sativum*) with imazamox Weed Tech 12 (1):64–68.

Brewster, B. D., D.M.Gamroth and C. Mallory-Smith. 1997. Control of annual grasses in imidazolinone-resistant winter with imazamox. WSWS Res. Prog. Rep., p. 92.

Dimitrova T., and S. Milanova. 2006. Influence of the adjuvant Desh on the efficacy and selectivity of imazamox 40 a i L^{-1} (Pulsar-40) in three perennial legume crops Herbologia 7 (1):41-46.

Gamroth, D. M., B. D.Brewster and C. Mallory-Smith. 1997 Screening of thirteen herbicides across sixteen grass species. WSWS Res. Prog Rep. pp. 39–40.

Harvey, R. G., J. W.Albright, T.M. Anthon, and J.L. Kutil. 1995. Annual weed control in canning peas. Proc. N. Cent. Weed Sci. Soc. 52:16–17.

Massinga, R., K. Al-Khatib, P. Stamand, and J. Miller. 2005. Relative fitness of imazamox resistant common sunflower and Prairie sunflower. Weed Sci. 53(2):166-174.

Moyer, J.R. and R. Esau. 1996. Imidazolinone herbicide effects on following rotational crops in Southern Alberta. Weed Tech.10 (1):100-106.

Neider, T. L. and D.C.Thill. 1997. Weed control in imidazolinone-resistant winter wheat with AC 299,263. WSWS Res. Prog. Rep., p. 101.

Nelson K.A., and K.A.Renner. 1998. Weed control in wide-and narrow-row soybean *(Glycine max)* with imazamox, imazethapyr, and CGA-277476 plus quizalfop. Weed Tech. 12 (1):137-144.

Ogg, P. J., G. Foster, D.J.Lyon, S.D.Miller, and P. Westra. 2001. Imazamox efficacy on different grass species in clearfield winter wheat in the Central Great Plains. Proc. West. Soc. Weed Sci. 54:73

O'Sullivan, J., R.J.Thomas and W.J.Bouw. 1998. Effect of imazethapyr and Imazamox soil residues on several vegetable crops grown in Ontario. Can. J. Plant. Sci. 78:647–651.

Rethwisch, M.D. and J.E.Nelson. 2000. Evaluation of Raptor and other herbicides for sowthistle, canarygrass and wild oat control in alfalfa. University of Arizona, College of Agriculture and Life Sciences, 2000 Forage and Grain A College of Agriculture and Life Sciences Report index at:http://cals.arizona.edu/pubs/crops/az1185/

Shaner, D.L., P.C.Anderson and M.A.Stidham. 1984. Imidazolinones, potent Inhibitors of Acetohydroxyacid Synthase. Plant Physiol. 76:545-546.

Stougaard, R., C.M. Smith, and J. Mickelson. 2004. Downy brome (*Bromus tectorum* L.) response to imazamox rate and application timing in herbicide-resistant wheat. Weed Tech..18:1043-1048.

Yenish, J.P. and N.A. Eaton. 2002. Weed control in dry pea (*Pisum sativum*) under conventional and no-tillage systems. Weed Tech. 16 (1):88-95.