Bulgarian Journal of Agricultural Science, 24 (Supplement 1) 2018, 33-39

EFFICACY OF HERBICIDES AND HERBICIDE COMBINATIONS AT SORGHUM (*SORGHUM BICOLOR* MOENCH.)

GROZI DELCHEV[1*] and TEODORA BARAKOVA[2]
[1]*Department of Plant Production, Faculty of Agriculture, Trakia University, 6000 Stara Zagora, Bulgaria*
[2]*Field Crops Institute, 6200, Chirpan, Bulgaria*

Abstract

DELCHEV, G., and T. BARAKOVA, 2018. Efficacy of herbicides and herbicide combinations at sorghum (*Sorghum bicolor* Moench.). *Bulg. J. Agric. Sci.*, 24 (Suppl. 1): 33–39

In the period 2012-2014 a field experiment was carried out with sorghum hybrid Arcansiel (*Sorghum bicolor* Moench.). A total of 4 soil-applied herbicides were tested - Tender EC (S-metholachlor), Silba SC (S-metholachlor + terbuthylazine), Sharpen 33 EC (pendimethalin) and Wing P (dimethenamid + pendimethalin) and 4 vegetation-applied herbicides - Casper 55 WG (prosulfuron + dicamba), Cambio SL (bentazone + dicamba), Camix 560 SE (S-metholachlor + mesotrione) and Maton 600 EK (2.4-D ester). In all variants seeds were treated with the herbicide antidote Concep III (fluxofenin) to protect sorghum from the phytotoxic effect of antigraminaceous herbicides. Soil-applied herbicides Tender, Silba, Sharpen and Wing have high efficacy against annual weeds in grain sorghum grown by Concep technology. Vegetation-applied herbicides Casper, Cambio and Maton have very high efficacy against all broadleaved weeds. Herbicide Camix is the only vegetation-applied herbicide, which can control secondary weeding of annual graminaceous weeds in sorghum which seeds are treated with herbicide antidote Concep III. The combinations between soil-applied and vegetation-applied herbicides control successfully all groups of weeds with the exception of perennial graminaceous weeds from rhizomes. Herbicide Camix causes poor phytotoxicity in sorghum plants. Use of herbicide combinations Silba + Casper and Wing + Cambio result in obtaining high grain yields of sorghum. High grain yields are also obtained through the use of herbicide combinations Silba + Cambio, Sharpen + Cambio, Tender + Casper and Wing + Casper. Combining Camix and Maton with soil-applied herbicides leads to lower grain yields.

Key words: grain sorghum; herbicides; herbicide combinations; selectivity; stability; grain yield

Introduction

The main weed species in sorghum crops are the annual late spring weeds. From the perennial weeds in sorghum areas problematic are *Sorgum helepense* Pers., *Cirsium arvense* Scop., *Convolvulus arvensis* L., etc. (Tsuru et al., 2005). According to Archangelo et al. (2002) and García (2005) with the conventional technology for grain sorghum growing it is impossible to chemically fight against graminaceous weeds, as it limits the growth of sorghum crop and because it applies high-cost operations – both mechanized and manual. The main problem at sorghum is its high sensitivity to graminaceous herbicides, which is why mechanical weed control must be carried out, but it makes production more expensive (Bibard, 2004). Vajs et al. (2007) reported that, herbicides and herbicide combinations, based on 2.4-D, bentazone, dicamba, bromoxynil, pentoxamide and florasulam can be used in sorghum without herbicide antidote as they show high yields and low phytotoxicity. The herbicide combinations based on linuron, isoxaflutole and mesotrione are highly phytotoxic to sorghum and therefore cannot be applied without specific antidotes.

Problems in control of graminaceous weeds at grain sorghum require the introduction of new Concep technology. Concep technology is based on the use of the herbicide antidote Concep III. It is used for seed treatment to protect sorghum from the phytotoxic effects of the active substances S-metolachlor, terbuthylazine, pendimethalin. It makes pos-

*E-mail corresponding author: delchevgd@dir.bg

sible the fight with annual graminaceous weeds to be carried out by herbicides as Dual gold, Gardoprim plus gold, Stomp, during the period after sowing before the emergence of sorghum (Joaquin, 1998; Roy et al., 2002). The effects of using a combination of pendimethalin and atrazine in sorghum are reported by Cruz (1991), and for using a combination of metolachlor and atrazine are reported by Shakoor et al. (2000).

The purpose of this investigation was to establish efficacy and selectivity of some soil-applied and vegetation-applied herbicides and their combinations on grain sorghum, which are grown by Concep technology under influence of different meteorological conditions.

Materials and methods

The research was conducted during 2010-2012 with sorghum hybrid Arcansiel (*Sorghum bicolor* Moench.). A two factors field experiment by a block method in 4 repetitions, on a 20 m^2 harvesting area, on *Pellic Vertisol* soil type, after durum wheat predecessor, was carried out. Factor A included non-treated control and 4 soil-applied herbicides – Tender EC, Silba SC, Sharpen 33 EC and Wing P. Factor B included non-treated control and 4 vegetation-applied herbicides – Casper 55 WG, Cambio SL, Camix 560 SE and Maton 600 EK. Active substances and doses of investigated herbicides are shown at Table 1.

In all variants seeds were treated with the herbicide antidote Concep III (fluxofenin) to protect sorghum from the phytotoxic effect of antigraminaceous herbicides.

The seeds were also treated with growth stimulator Lactisem sorghum at 3 l per 100 kg^{-1} to overcome the biologically slow initial growth. All variants were treated in the 8 leaf stage of sorghum with complex foliar fertilizer Lactofol sorghum at 10 $l.ha^{-1}$ to accelerate the development and flowering before the onset of summer drought. All of the variants were treated with a working solution of 200 $l.ha^{-1}$.

The efficacy and selectivity of herbicides and their combinations were investigated. Their influence on grain yield was established. Efficacy of herbicides against weeds and volunteers of sunflower was appointed according to 100% scale of EWRS (European Weed Research Society). Selectivity of herbicides for sorghum plants was followed according to the 9-rate scale of EWRS (rating 1 - without damages, rating 9-crop is completely destroyed). The mathematical processing is done with analysis of variance method.

Results and discussion

Dominant weeds which determine the secondary weed infestation in the experiment field are late spring annual broadleaved species *Xanthium strumarium* L., *Amaranthus retroflexus* L., *Amaranthus albus L.*, *Chenopodium album* L., *Solanum nigrum* L., *Datura stramonium* L., *Abutilon teophrasti* Medic., *Portulaca oleracea* L., *Polygonum aviculare* L., *Hibiscum trionum* L., and in a small amount *Amaranthus blifoides* W. and *Tribulus terrestris* L. Annual graminaceous weeds are represented by *Echinochloa crus-galli* L., *Echinochloa coarctata* Vas., *Panicum sanguinale* L., *Setaria*

Table 1
Investigated variants

№	Variants	Active substance	Doses
Factor A – treatment after sowing – before emergence			
1	Control	-	-
2	Tender EC	S-metholachlor	1.5 $l.ha^{-1}$
3	Silba SC	S-metholachlor + terbuthylazine	3.5 $l.ha^{-1}$
4	Sharpen 33 EC	pendimethalin	4.5 $l.ha^{-1}$
5	Wing P	pendimethalin + dimethenamid	4 $l.ha^{-1}$
Factor B – treatment during stage 5-7 leaf			
1	Control	-	-
2	Casper 55 WG	prosulfuron + dicamba	300 $g.ha^{-1}$
3	Cambio SL	bentazone + dicamba	2 $l.ha^{-1}$
4	Camix 560 SE	S-metholachlor + mesotrione	2.5 $l.ha^{-1}$
5	Maton 600 EK	2,4-D 2-ethylhexyl ester	1.2 $l.ha^{-1}$

In all variants seeds were treated with the herbicide antidote Concep III (fluxofenine)

viridis Beauv., *Setaria glauca* Beauv. As a single plant the presence of *Setaria verticilata* Beauv. is observed. Perennial species in experiment are broadleaved weeds *Cirsium arvense* Scop., *Convolvulus arvensis* L. and graminaceous weed *Sorghum helepense* Pers. mainly by seeds. Volunteers of sunflower (*Helianthus annuus* L.) are from sunflower which was grown as a predecessor two years before the experiment. In the year before the sorghum was grown, durum wheat (*Triticum durum* Desf.) was the immediate predecessor.

Herbicide Silba, treated after sowing before emergence period, has very high efficacy against late spring annual broadleaved weeds *Amaranthus retroflexus* L., *Chenopodium album* L., *Solanum nigrum* L., *Datura stramonium* L., *Portulaca oleracea* L., *Polygonum aviculare* L., *Hibiscum trionum* L. (Table 2). Herbicides Sharpen and Wing also have very high efficacy against these weeds. From the group of soil-applied herbicides only Tender has less antibroadleaved effect. Its efficacy against annual broadleaved weeds varies

Table 2
Efficacy of some soil-applied and vegetation-applied herbicides against broadleaved weeds at sorghum according to the 100% visual scale of EWRS (2012-2014)

Herbicides		Weeds							
Soil-applied	Foliar-applied	*Xanthium strumarium*	*Amaranthus retroflexus*	*Chenopodium album*	*Solanum nigrum*	*Datura stramonium*	*Portulaca oleraceae*	*Cirsium arvense*	*Convolvulus arvensis*
-	-	0	0	0	0	0	0	0	0
	Casper	100	100	100	100	100	100	100	98
	Cambio	100	100	100	100	100	100	100	90
	Camix	66	100	100	100	100	82	54	15
	Maton	94	96	98	98	95	92	72	64
Tender	-	0	87	82	78	80	88	0	0
	Casper	100	100	100	100	100	100	100	98
	Cambio	100	100	100	100	100	100	100	90
	Camix	66	100	100	100	100	100	54	15
	Maton	94	96	98	98	95	92	72	64
Silba	-	0	100	100	100	100	100	0	0
	Casper	100	100	100	100	100	100	100	98
	Cambio	100	100	100	100	100	100	100	90
	Camix	66	100	100	100	100	100	54	15
	Maton	94	100	100	100	100	100	72	64
Sharpen	-	0	100	100	100	95	100	0	0
	Casper	100	100	100	100	100	100	100	98
	Cambio	100	100	100	100	100	100	100	90
	Camix	66	100	100	100	100	100	54	15
	Maton	94	100	100	100	95	100	72	64
Wing	-	0	100	93	100	80	100	0	0
	Casper	100	100	100	100	100	100	100	98
	Cambio	100	100	100	100	100	100	100	90
	Camix	66	100	100	100	100	100	54	15
	Maton	94	100	98	100	95	100	72	64

from 78 to 88%. Soil-applied herbicides Tender, Silba, Sharpen and Wing are inefficacious against *Xanthium strumarium* L.. Abdel-Gadir et al. (2009) report that Dual Gold provides excellent control of annual cereal weeds (95-100%) and satisfactory control of annual broadleaved weeds (50-66%). Addition of atrazine increases its efficacy against broad-leaved weeds to 90-97% (Abdel-Gadir et al., 2009).

Herbicides from this group cannot control perennial broadleaved weeds *Cirsium arvense* Scop. and *Convolvulus arvensis* L. At presence of such weeds, it is necessary for sorghum fields to be treated during the vegetation with foliar antibroadleaved herbicides.

Vegetation-applied herbicides Casper and Cambio treated during 3-7 leaf stage of sorghum have very high efficacy against all late spring annual broadleaved weeds, including *Xanthium strumarium* L. They also have very good efficacy against perennial broadleaved weeds *Cirsium arvense* Scop. and *Convolvulus arvensis* L. Awad et al. (1991) also reported that dicamba-based herbicides successfully control annual and perennial broadleaved weeds during sorghum vegetation.

Herbicide Camix has less antibroadleaved effect. It is less efficacious against *Xanthium strumarium* L. *and Cirsium arvense* Scop. and mostly efficacious against *Convolvulus arvensis* L.

Herbicide Maton has very high efficacy against annual broadleaved weeds, including *Xanthium strumarium* L., but it is less efficacious against *Cirsium arvense* Scop. and *Convolvulus arvensis* L. Hormone-similar herbicide Maton destroys only their over-ground parts, but later new shoots appear and the weeds recover, particularly where the crop is sparse. Therefore, this herbicide should be used in the absence of perennial broadleaved weeds.

Soil-applied herbicides Silba, Sharpen and Wing have high efficacy against annual graminaceous weeds *Echinochloa crus-galli* L., *Echinochloa coarctata* Vas., *Panicum sanguinale* L., *Setaria viridis* Beauv., *Setaria glauca* Beauv. (Table 3). Herbicide Tender has very good antigraminaceous effect, but has less antibroadleaved effect, so it should be used mainly at infestation with predominant annual graminaceous weeds.

Soil-applied herbicides Tender, Silba, Sharpen and Wing control successfully *Sorghum helepense* Pers. from seeds, but are inefficacious against *Sorghum helepense* Pers. from rhizomes, *Cynodon dactylon* Pers. and *Agropirum repens* L.

Vegetation-applied herbicides Casper, Cambio and Maton, treated during 3-7 leaf stage of sorghum are inefficacious against annual graminaceous weeds. They are typical antibroadleaved herbicides and should be used after soil-applied herbicides treated after sowing before emergence period at sorghum grown by Concep technology.

Herbicide Camix although is less efficacious against broadleaved weeds *Xanthium strumarium* L., *Cirsium arvense* Scop. and *Convolvulus arvensis* L., but is the only one of vegetation-applied herbicides that has high efficacy against annual graminaceous weeds. Camix is also the only one of herbicides by sorghum, which can fight the secondary weed infestation with annual graminaceous weeds.

None of the investigated soil-applied herbicides Tender, Silba, Sharpen and Wing, are efficacious against sunflower volunteers. If there are many volunteers it is imperative to apply earlier treatment with any of the vegetation-applied antibroadleaved herbicides Casper, Cambio, Camix or Maton, which have high efficacy against them.

Combinations between soil-applied and vegetation-applied herbicides control successfully all groups of weeds, with the exception of perennial graminaceous weeds from rhizomes. For this reason, the fight against *Sorghum helepense* Pers. from rhizomes, and other perennial weeds such as *Cynodon dactylon* Pers. and *Agropirum repens* L. should be carries earlier - in the predecessor crops, and during the sorghum vegetation the fight with their seeds should be to prevent their re-multiplication.

Specifically in this experiment, the fight against perennial graminaceous weeds was done after the predecessor harvesting - durum wheat, during the stubble period. Antigraminaceous herbicide Targa super in dose 3 l/ha was used, treated in stage 3-5 leaf of weeds and 10-20 cm height of *Sorghum helepense* Pers. In the previous year sunflower was grown before the durum wheat and the fight against weeds including perennial graminaceous weeds was done by ClearField and ExpressSun technologies.

Treatment with herbicide Camix causes phytotoxicity in sorghum plants - rating 2 by scale of EWRS (Table 3). The herbicide did not show initially any systematic effect and damage to sorghum expressed in contact chlorosis and necrosis on the leaves where the herbicides were applied. Signs of phytotoxicity by Camix appear 4-5 days after treatment. Duration of the full recovery of affected plants is from 15 to 20 days. Later phytotoxicity on the leaves is overcome by sorghum and does not lead to mathematically proven reduction in grain yield, due to better efficacy of the herbicides against weeds and volunteers of ClearField and ExpressSun sunflower. Camix's higher phytotoxicity has been also reported in our other studies (Delchev, 2013).

The reason for the lower selectivity of the herbicide Camix is the insufficient after-action on it of the herbicide antidote Concept III. Herbicide Camix contains the active substance S-metolachlor like herbicide Tender. While in the soil-applied herbicide Tender, antidote fluxofenine applied after the sowing and before emergence period, effects from seed to

Table 3
Efficacy of some soil-applied and vegetation-applied herbicides against graminaceous weeds and volunteers at sorghum according to the 100% visual scale of EWRS and selectivity according to the 9-rate scale of EWRS (2012-2014)

Herbicides		Weeds							Selectivity
Soil-applied	Foliar-applied	*Echinochloa crus-gali*	*Echinochloa coarctata*	*Setaria viridis*	*Setaria glauca*	*Digitaria sangvinale*	*Sorgum helepense**	*Helianthus annuus**	
-	-	0	0	0	0	0	0	0	1
	Casper	0	0	0	0	0	0	100	1
	Cambio	0	0	0	0	0	0	100	1
	Camix	98	98	97	97	100	98	100	3
	Maton	0	0	0	0	0	0	100	1
Tender	-	98	98	97	97	100	98	0	1
	Casper	98	98	97	97	100	98	100	1
	Cambio	98	98	97	97	100	98	100	1
	Camix	100	100	100	100	100	100	100	3
	Maton	98	98	97	97	100	98	100	1
Silba	-	98	98	97	97	100	98	0	1
	Casper	98	98	97	97	100	98	100	1
	Cambio	98	98	97	97	100	98	100	1
	Camix	100	100	100	100	100	100	100	3
	Maton	98	98	97	97	100	98	0	1
Sharpen	-	97	97	98	98	95	90	0	1
	Casper	97	97	98	98	95	90	100	1
	Cambio	97	97	98	98	95	90	100	1
	Camix	100	100	100	100	100	100	100	3
	Maton	97	97	98	98	95	90	100	1
Wing	-	100	100	100	100	100	96	0	1
	Casper	100	100	100	100	100	96	100	1
	Cambio	100	100	100	100	100	96	100	1
	Camix	100	100	100	100	100	100	100	3
	Maton	100	100	100	100	100	96	100	1

*- *Sorgum helepense* Pers. from seeds only
**- volunteers of ClearField and ExpressSun sunflower

plant and directly degrades S-metolachlor, in the vegetation-applied herbicide Camix during stage 3-7 leaf of sorghum, antidotal effect is reduced and antidote Concep III no longer guarantees 100% protective effect.

Soil-applied herbicides Tender, Silba, Sharpen and Wing and vegetation-applied herbicides Casper, Cambio and Maton have very high selectivity for sorghum which is grown by Concep technology - rating 1 by scale of EWRS.

Grain yield is a result of the additive effect of the efficiency and selectivity of the studied herbicides and herbicide combinations (Table 4). When used single, soil herbicides Tender, Silba, Sharpen and Wing, and vegetation herbicides

Table 4
Influence of some soil-applied and foliar-applied herbicides on grain yield of sorghum (2012-2014)

Herbicides		2012		2013		2014		Mean	
Soil-applied	Foliar-applied	kg.ha^{-1}	%	kg.ha^{-1}	%	kg.ha^{-1}	%	kg.ha^{-1}	%
	-	3741	100	3902	100	4388	100	4010	100
	Casper	4444	118.8	4612	118.2	5266	120.0	4774	119.1
-	Cambio	4429	118.4	4577	117.3	5274	120.2	4760	118.7
	Camix	4257	113.8	4410	113.0	5318	121.2	4662	116.3
	Maton	4231	113.1	4378	112.2	5230	119.2	4613	115.0
	-	4403	117.7	4569	117.1	5266	120.0	4746	118.4
	Casper	4695	125.5	4870	124.8	5577	127.1	5047	125.9
Tender	Cambio	4654	124.4	4890	125.3	5546	126.4	5030	125.4
	Camix	4493	120.2	4725	121.1	5388	122.8	4869	121.4
	Maton	4530	121.1	4760	122.0	5371	122.4	4887	121.9
	-	4340	116.0	4495	115.2	5226	119.1	4687	116.9
	Casper	4714	126.0	4881	125.1	5612	127.9	5069	126.4
Silba	Cambio	4676	125.0	4913	125.9	5582	127.2	5057	126.1
	Camix	4482	119.8	4749	121.7	5353	122.0	4861	121.2
	Maton	4560	121.9	4749	121.7	5415	123.4	4908	122.4
	-	4411	117.9	4585	117.5	5279	120.3	4758	118.7
	Casper	4661	124.6	4901	125.6	5546	126.4	5036	125.6
Sharpen	Cambio	4680	125.8	4878	125.0	5582	127.2	5047	125.7
	Camix	4545	121.5	4800	123.0	5472	124.7	4939	123.2
	Maton	4564	122.0	4815	123.4	5485	125.0	4955	123.6
	-	4429	118.4	4600	117.9	5309	121.0	4779	119.2
	Casper	4676	125.0	4909	125.8	5573	127.0	5053	126.0
Wing	Cambio	4714	126.0	4885	125.2	5612	127.9	5070	126.4
	Camix	4545	121.5	4838	124.0	5485	125.0	4956	123.6
	Maton	4572	122.2	4854	124.4	5511	125.6	4979	124.2
	LSD 0.5	240	6.4	265	6.8	274	6.2		
	LSD 0.1	275	7.4	308	7.9	318	7.2		
	LSD 0.01	333	8.9	359	9.2	372	8.5		

Casper, Cambio, Camix, Maton, grain yield increases, as part of the weeds are destroyed. Yet the increase in yield is lesser compared to the combined use, because when herbicides are applied single, part of the dominant weeds in the experiment cannot be destroyed.

The highest grain yields are achieved by treating with herbicide combinations Silba + Casper, and Wing + Cambio – 27.9% control over weeds. Very high and close to these are yields through herbicide combinations Silba + Cambio, Sharpen + Cambio, Tender + Casper, and Wing + Casper.

Grain yields are lower under the treatment of combinations involving herbicides Camix and Maton. In Camix the decrease in grain yield compared to the other herbicides is due to the greater phytotoxicity. This herbicide should be used primarily in secondary weed infestation with annual graminaceous weeds. So far Camix is the only solution to control them in grain sorghum. In herbicide Sanafen the decrease in grain yield compared to the other herbicides is due to the lower efficiency of the herbicide against perennial broadleaved weeds.

Conclusions

Soil-applied herbicides Tender, Silba, Sharpen and Wing have high efficacy against annual weeds in grain sorghum grown by Concep technology.

Vegetation-applied herbicides Casper, Cambio and Maton have very high efficacy against all broadleaved weeds.

Herbicide Camix is the only vegetation-applied herbicide, which can control secondary weeding by annual graminaceous weeds in sorghum vegetation, which seeds are treated with herbicide antidote Concep III.

The combinations between soil-applied and vegetation-applied herbicides control successfully all groups of weeds with the exception of perennial graminaceous weeds from rhizomes.

Herbicide Camix causes poor phytotoxicity in sorghum plants.

Herbicide combinations Silba + Casper and Wing + Cambio result in obtaining high grain yields of sorghum.

High grain yields are also obtained in the herbicide combinations Silba + Cambio, Sharpen + Cambio, Tender + Casper and Wing + Casper.

Combining Camix and Maton with soil-applied herbicides leads to lower grain yields.

References

Abdel-Gadir, H., D. Dawoud, E. Abdel-Aziz, A. Hamada and A. Babiker, 2009. Effects of Dual gold 96% EC (S-metolachlor) alone or in mixture with atrazine on preemergence weed control in sorghum. *Sudan Journal of Agricultural Research*, **14**: 81-94.

Archangelo, E. R., J. B. da Silva, A. A. da Silva, L. R. Ferreira and D. K. Karam, 2002. Forage sorghum tolerance to Primestra SC herbicide. *Revista Brasileira de Milho e Sorgo*, **1**(2): 59-66.

Awad, A., A. Worsham, R. Eplee and R. Norris, 1991. Effects of dicamba, nitrogen and presowing hardening of host seed with phenolic acids on witchweed (Striga asiatica) control in grain sorghum (Sorghum bicolor). In: *Proceedings of the 5-th international symposium of parasitic weeds*, Nairobi (Kenya), pp. 537-538.

Bibard, V., 2004. Weed control of sorghum crops: choose the right farming practices in order to facilitate chemical protection. *Phytoma. La Défense des Végétaux*. **569**: 45-48.

Cruz Chacón, R., 1991. Activacion de dos herbicidas y su incidencia en el control de caminadora (*Rottboellia exaltata* L) en un cultivo de sorgo (*Sorghum bicolor* Moench) ubicado en un suelo de vega. PhD Thesis, Santafé de Bogotá, Villavicencio (Colombia).

Delchev, Gr., 2013. Efficacy and selectivity of soil-applied and vegetation-applied herbicides at grain sorghum, grown by Concep technology. *Journal of Mountain Agriculture on the Balkans*, **16**(2): 440-454.

García, R., 2005. Potencialidades de maíz, millo y girasol como cultivos alelopáticos para el control de malezas. *Fitosanidad*, **9**(3): 23-26.

Joaquin, T. S., 1998. Protection activity of fluxofenim (Concep III) applied on sorghum grain *Sorghum bicolor* Moench. against the action of metolaclor in two different environments. PhD Thesis.

Roy, C., F. Guggiari and J. Compagnon, 2002. S-metolachlor, maize, sorghum and sunflower herbicide. *Phytoma. La Défense des Végétaux*, **548**: 51-53.

Shakoor, A., S. Islam and M. Naeem, 2000. Efficacy of different herbicides for control of weeds in sorghum (*Sorghum bicolor* L) under rainfed conditions. *Pakistan Journal of Biological Science*, **3**(3): 463-465.

Tsuru, M., H. Watanabe, S. Kasuga and M. Momoze, 2005. Weed control by broadcasting and dense sowing of forage sorghum (*Sorghum bicolor* Moench). *Japanese Journal of Grassland Scienc*e, **51**(2): 152-156.

Vajs, S., R. Leskovsek, J. Miklavc, B. Matko and M. Lesnik, 2007. Possibilities of chemical weed control in sorghum (*Sorghum bicolor* Moench) fields. *8-th Slovenian Conference on Plant Protection*, Radenci (Slovenia), pp. 88-98.