WEED MANAGEMENT IN SWITCHGRASS CROP

M. Minelli, L. Rapparini e G. Venturi
Department of Agroenvironmental Sciences and Technologies, University of Bologna, Viale G. Fanin 44, 40127 Bologna,
Tel.: 051.2096669, Fax: 051.2096241, email: mminelli@agrsci.unibo.it

Research carried out in the project "Bioenergy chain from perennial crops in South Europe", coordinated by Dr. Myrsini Christou

ABSTRACT: Switchgrass establishment can be seriously hampered by weed competion. Consequently, the setting up of effective weed management techniques is of particular interest. Several pre-emergence (PRE) and post-emergence (POST) herbicides were tested on a 1st year switchgrass crop, together with other agronomical practices, such us false seedbed and weed clipping. Best weed control and selectivity on switchgrass were obtained with the POST herbicide nicosulfuron, applied at reduced doses (10-20 g ha^{-1}), alone or mixed with dicamba and MCPA.
Keywords: switchgrass, biomass production, ash, weed management, nicosulfuron

1 INTRODUCTION

Switchgrass (*Panicum virgatum* L.) is a perennial biomass species characterized by high seed dormancy, low seed vigour and slow seedling growing [1]. As a consequence, switchgrass establishment often requires several weeks and weed competition can be particularly troublesome. Moreover, some weeds are unsuitable for combustion because of their high ash content. For example, johnsongrass (*Sorghum halepense* L.) ash content ranges from 5.9 to 11.3% [7]. Therefore, in order to produce switchgrass biomass with good and constant processing quality, weed management is required.

Switchgrass establishment can be improved both by means of switchgrass seed treatments, aimed to improve germination and seedling emergence, and by means of weed management.

Several seed treatments, as acid scarification, NaOCl treatment and pre-chilling, have been successfully tested on switchgrass [4, 14] but their application on high amount of seed could be difficult and time consuming.

As regards weed management, herbicides application can greatly enhance switchgrass establishment [15]. From the 1970's, several chemical weed control trials have been carried out in the United States. Some authors [12, 13] reported that pre-emergence applications of atrazine and simazine gave significantly better broadleaves control, without phytotoxic effects on the crop, than dalapon, which caused severe injuries to switchgrass. Similar results were obtained in other researches [6, 8, 10]. Kassel et al. [5] observed an effective control of *Setaria viridis* and a satisfactory crop establishment using a mixture of atrazine and simazine. Vogel and Masters [16] found the selectivity of quinclorac, isoxaflutole, imazapic and imazetaphyr comparable with that of atrazine. Peters et al. [11] investigated several POST herbicides and observed percentages of crop injury ranging from 45 to 96%.

On the basis of available literature, the information on switchgrass chemical weed control is incomplete. Atrazine gives a satisfactory weed control and is characterized by an excellent selectivity on switchgrass but its utilization is forbidden in Europe. Moreover, atrazine is not sufficiently effective against noxious weeds with deep, rhizomatous root system such us johnsongrass.

This research, carried out since 2002, was aimed to find herbicides selective on switchgrass and also to evaluate the possibility of integrate chemical weed control in switchgrass with agronomical weed management techniques, such as false seedbed and weed clipping.

2 MATERIALS AND METHODS

Field plot trial and open field trials were carried out. Field plot trial were aimed to perform, on switchgrass, a selectivity and effectiveness screening of several herbicides.

Open field trials were aimed to validated field plot trial results and also to test agronomical weed management techniques.

2.1 Field plot trial

Several PRE and POST herbicides, previously submitted to preliminary greenhouse selectivity tests, were applied to switchgrass cultivars Alamo and Kanlow during the establishment year of the crop.

Experimental design was a split-block with PRE herbicides applied in main plot stripes and POST herbicides applied in subplot stripes. A no treated check was included. In tab. 1 tested herbicides tested are reported.

Tab. 1: tested herbicides

herbicide	application dose (g ha^{-1})	application time
terbuthylazine	560	PRE
simazine	537	PRE
pendimethalin	1228	PRE
dicamba + MCPA	28 + 318	POST
ioxynil + mecoprop	476 + 1073	POST
nicosulfuron	20	POST
nicosulfuron + dicamba + MCPA	20 + 28 + 318	POST
nicosulfuron +ioxynil + mecoprop	20 + 476 + 1073	POST

PRE herbicides were evaluated in terms of selectivity on switchgrass, quantified as number of emerged and viable switchgrass plants m^{-2}, and in terms of effectiveness on weeds, expressed as weed infestation level (0 = no weeds; 5 = crop completely infested).

POST herbicides were applied when switchgrass was at 3rd-5th leaf stage and were evaluated by means of weed and switchgrass dry biomass production measurements, carried out in autumn harvesting a biomass sample per each plot.

2.2 Open field trials

Herbicides which performed better in the field plot trial were open field tested, according different application doses and timing. Results were expressed as visual observations of effectiveness on weeds and selectivity on switchgrass.

False seedbed and weed clipping were experimented in the same way.

3 RESULTS AND DISCUSSION

3.1 Field plot trial

Concerning PRE herbicides, simazine and terbuthylazine, compared with no treated check, caused a reduction of emerged switchgrass plants m^{-2} ranging from 10 to 20%, whereas in pendimethalin treated plots a switchgrass mortality higher than 50% was observed. Unfortunately, pendimethalin resulted also the most effective herbicide. Therefore, PRE herbicides tested in this study cannot be utilized on switchgrass.

POST herbicides results are reported in fig. 1 and fig 2.

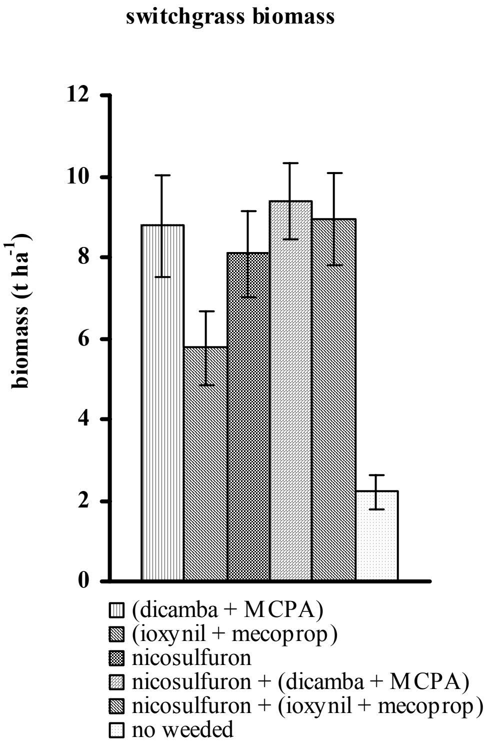

Fig. 1. POST herbicides effects on switchgrass dry biomass production (means with standard errors).

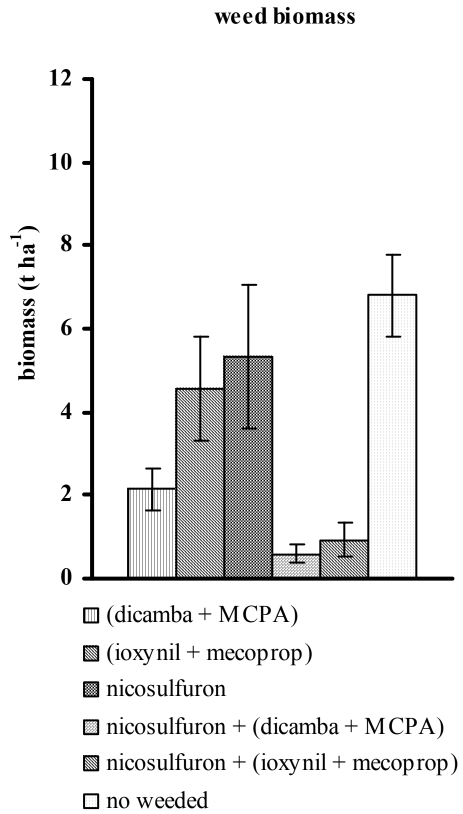

Fig. 2. POST herbicides effects on weeds dry biomass production (means with standard errors).

The highest switchgrass biomass production, together with the lowest weed biomass production, was obtained with the tank mix nicosulfuron (20 g ha^{-1}) plus dicamba (28 g ha^{-1}) plus MCPA (318 g ha^{-1}). These results can be explained taking into account that these herbicides are complementary in terms of activity spectrum: nicosulfuron is active on several grass and broadleaf weeds but not on *Chenopodium* spp. which is controlled by the pre-formulated mix dicamba plus MCPA. Moreover, nicosulfuron is characterized by a good effectiveness against johnsongrass. The limit of this sulphonylurea is that can be quite phytotoxic on switchgrass, as reported by Curran et al. [2]. In our research, phytotoxicity was observed spraying nicosulfuron at 40 g ha^{-1}, the dose normally applied on corn. Switchgrass damages consisted of epigean apparatus chlorosis and growing rate decreasing. In the next paragraph, results of open field nicosulfuron applications are reported.

3.2 Open field trials

These trials were carried out on the switchgrass variety Alamo.

In order to study the relationship between phytotoxicity and application dose, nicosulfuron was applied at 40 g ha^{-1} (full dose), 20 g ha^{-1} (half dose) and at 10 g ha^{-1} (micro dose).

The full dose, applied only one time, gave immediately a good weed control, as it was expected, but caused also quite strong phytotoxicity symptoms which lasted for a month.

The half dose, applied twice and observing a interval between treatments of 2 weeks, gave a good weed control together with a appreciable reduction of switchgrass damages.

The micro dose, applied three times observing a interval between consecutive treatments of 7-10 weeks, resulted effective on weeds and characterized by a phytotoxicity very slight and temporary. Obviously, this technique was also the most time consuming but, compared to others, allowed a reduction of 25% of the total nicosulfuron consumption.

In 2003, these open field test was continued with the tank mix nicosulfuron (10 g ha^{-1}) plus dicamba (28 g ha^{-1}) plus MCPA (318 g ha^{-1}). Nicosulfuron dose was reduced, compared to the one applied in field plot trial during 2002, in order to avoid phytotoxicity. Good results were obtained, both in terms of effectiveness on weeds and in terms of selectivity. Moreover, due to the increased crop competitiveness, 2 treatments resulted sufficient to get a satisfactory weed control.

Concerning agronomical weed management techniques, they were tested in 2002. Weed clipping, performed with a chopper working at a chopping height ranging from 10 to 30 cm, resulted effective but its effects on weeds were quite temporary, particularly on developed, invasive weeds characterized by a high re-growth capacity, such as *Sorghum halepense* and *Amaranthus retroflexus*. Furthermore, reducing chopping height the effectiveness against weeds increased but also switchgrass resulted more damaged. False seedbed resulted a useful technique but delayed switchgrass sowing and, as a consequence, the crop suffered more drought stress during the summer.

4 CONCLUSIONS

4.1 Weed management techniques

Weed competition is particularly noxious for switchgrass during crop establishment year. From the 2nd year, crop competitiveness improves and weed management became less difficult and less expensive.

In presence of grass and broadleaf weeds, the tank mix nicosulfuron (10 g ha^{-1}) plus dicamba (28 g ha^{-1}) plus MCPA (318 g ha^{-1}) gives good weed control together with low and temporary phytotoxicity on switchgrass. During the establishment year, it is important to start herbicide application not before the switchgrass stage of 3rd-5th leaf. Moreover, as a general rule, herbicide applications on crops suffering for drought stress and with temperature higher than 30° C should be avoided.

Concerning selectivity aspects, in case of switchgrass cultivars different from the ones utilized in this research (Alamo and Kanlow), nicosulfuron, dicamba and MCPA selectivity must be checked before open field application.

False seedbed and weed clipping seemed to be not sufficiently effective against severe weed infestation but can be utilized as integration of chemical weed control.

REFERENCES

[1] Beckman J.J., Moser L.E., Kubik K., and Waller S.S. (1993). Big bluestem and switchgrass establishment as influenced by seed priming. Agron. J., 85: 199-202.

[2] Curran W.S., Shaffer J.A., Schnabel R.R., and Werner E.L. (1998). Switchgrass tolerance to several pre and post applied corn herbicides. http://weeds.cas.psu.edu/switchgrass.html.

[3] Griffin T.S., Moser L.E., and Martin A.R. (1988). Influence of antidotes on forage grass seedling response to metolachlor and butylate. Weed Sci. 36: 202-206.

[4] Haynes J.G., Pill W.G., and Evans T.A. (1997). Seed treatments improve the germination and seedling emergence of switchgrass (*Panicum virgatum* L.). Hortsci. 32(7): 1222-1226.

[5] Kassel P.C., Fawcett J.A., Myers G.E. and Nelson J.E. (1982). Herbicides for switchgrass establishment. Proc. North Cent. Weed Control Conf. 99.

[6] Kern C.L. (1976). The use of atrazine as an aid in switchgrass establishment. Proc. North Cent. Weed Control Conf. 31: 98-99.

[7] Miller D.F. (1958). Composition of cereal grains and forages. National Academy of Sciences, National Research Council, Washington, DC. Publ. 585.

[8] Moomaw R.S. and Martin A.R. (1978). Establishment of several warm season grass species with atrazine. Proc. North Cent. Weed Control Conf. 33: 128-131.

[9] Moser L.E. and Vogel K.P. (1995). Switchgrass, big bluestem and indiangrass. Chapter 32. p. 409-420.

[10] Peters E.J. and Lowance S.A. (1976). Herbicides for control of weeds in warm season forage grasses. Proc. North Cent. Weed Control Conf. 30, 46.

[11] Peters J.P., Moomaw R.S., and Martin A.R. (1989). Herbicides for postemergence control of annual grass weeds in seedling forage grasses. Weed Sci. 37: 375-379.

[12] Smith C.N. (1972). Herbicide residue and weed control in switchgrass. Dissertation Abstracts International, 32: 5, 2485.

[13] Smith C.N. Jr. (1971). Herbicide residue and weed control in switchgrass. Dissertation Abstracts International, 32: 5, 2485.

[14] Tischler C.R., Young B.A. and Sanderson M.A. (1994). Techmiques for reducing seed dormancy in switchgrass. Seed Sci. Technol. 22: 19-26.

[15] Vogel K.P. (1987). Seeding rates for establishing big bluestem and switchgrass with pre-emergence atrazine applications. Agron. J. 79: 509-512.

[16] Vogel K.P., and Masters R.A. (1998). Developing switchgrass into a biomass fuel crop for the Midwestern USA. Paper presented at Bioenergy '98: Expanding Bioenergy Partnerships, Madison, Wisconsin, October 4-8, 1998.