

## Herbicide and phytotoxicity effects of foramsulfuron in Korean lawn grass (*Zoysia japonica*)

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**Summary** This study was conducted to determine whether foramsulfuron OD (oil-based suspension concentrate) can provide adequate control of common weeds of Korean lawn grass (*Zoysia japonica* Steud.). Six trials were conducted at five South Korean locations in 2010 and 2011 to evaluate the herbicidal activity and phytotoxicity of foramsulfuron. Foliar applications of foramsulfuron at a concentration of 46 g a.i. ha<sup>-1</sup> provided >89% control against annual weeds, such as *Erigeron canadensis* L., *Digitaria ciliaris* (Retz.) Koel., *Cyperus amuricus* Maxim. and *Poa annua* L. Foramsulfuron also provided >88.8% control of perennial weeds, such as *Taraxacum platycarpum* Dahlstedt., *Artemisia princeps* Pamp. and *Trifolium repens* L. Korean lawn grass showed early signs of phytotoxicity after foramsulfuron treatments at 46 g a.i. ha<sup>-1</sup> and 92 g a.i. ha<sup>-1</sup>, but plants recovered by 40 days after treatment. Foramsulfuron may be useful in general weed control in Korean lawn grass.

**Keywords** Foramsulfuron, Korean lawn grass, weed, *Zoysia japonica*, efficacy test.

### INTRODUCTION

*Zoysia* grasses are grown primarily in warm and humid regions. Korean lawn grass forms a uniform, dense, low growing, high quality turf that has a slow rate of growth. Although this grass is slow to green up in spring and has slow establishment and recovery rates, it is successfully used in parks, golf courses and sports fields because of its ability to adapt to a wide range of soils and outstanding tolerance to wear, drought and salt (Turgeon 1996).

Currently, thirty-seven species of weeds from 16 families, including three species of Cyperaceae (e.g., *Cyperus sanguinolentus* Vahl.) nine species of Poaceae (e.g., *Digitaria ciliaris* and *Poa annua*), and 25 species of broad-leaved weeds, such as *Artemisia princeps*, *Draba nemorosa* L. and *Hydrocotyle sibthorpioides* Lam., are problematic in the zoysia grass lawns in South Korea (Lee *et al.* 2013). In order to control these weeds, over 60 herbicides were registered in South Korea as of 2013. However, some of these herbicides have become less effective and resistance sometimes occurs.

Foramsulfuron is a new herbicide in the South Korean market. It belongs to the sulfonyleurea chemical group, which causes inhibition of acetolactate synthase ALS (acetohydroxyacid synthase) (APVMA 2011). Foramsulfuron is used as a post-emergence herbicide for grass and broad-leaf weed control in maize; it is applied at 30–60 g ha<sup>-1</sup> (Tomlin 2009).

The purpose of this study was to determine whether foramsulfuron OD can be used for control of several grass and broad-leaf weeds in Korean lawn grass.

### MATERIALS AND METHODS

Field experiments were conducted at five field sites on sandy loam soils in 2010 and 2011. The trial regions were Yeosu (37°21'47"N, 127°41'51"E), Gunpo (37°20'22"N, 126°56'31"E), Goyang (37°39'27"N, 126°51'15"E), Jinju (35°14'42"N, 128°09'16"E) and Anseong (37°05'42"N, 127°14'54"E) in South Korea.

We trialed two rates of foramsulfuron (Tribute® OD 2.3% Bayer CropScience, South Korea): 46 g a.i. ha<sup>-1</sup> (measuring herbicidal activity and phytotoxicity) and 92 g a.i. ha<sup>-1</sup> (measuring phytotoxicity only) and one rate of the herbicide Flazasulfuron WP (Parandeu® 10% Dongbu Farm Hannong, South Korea) 75 g a.i. ha<sup>-1</sup> (measuring herbicidal activity only). All treatments were applied at 2–3 leaf stage of *Digitalis ciliaris*.

Experimental design was a randomised complete block design with three replications per treatment and plot sizes of 20 m<sup>2</sup>.

Weed control evaluations were made at 30 DAT (days after treatment) by percent (%) reduction in dry weight relative to the untreated control. Phytotoxicity was recorded at 10, 20, 30 and 40 DAT by visual assessment using a 0–9 scale (0 = no injury, 9 = killed).

Data was analysed using SAS (9.2, SAS Institute Inc.). Treatment means were compared by Duncan's multiple range test at 5% level of significance.

### RESULTS

**Herbicidal activity** Foramsulfuron OD at 46 g a.i. ha<sup>-1</sup> provided 88.8 to 90.3% control of annual weeds in Korean lawn grass, with resulting weed dry weights

of 0.8 to 1.0 g (Table 1) and 88.3 to 94.8% control of perennial weeds in Korean lawn grass, with resulting weed dry weights of 0.5 to 2.6 g (Table 2). These results were similar to Flazasulfuron WP at 75 g a.i. ha<sup>-1</sup>, which provided 82.9 to 90.3% control and 0.7 to 1.5 g weed dry weights (Table 1) of annual weeds, and 84 to 94.1% control and 0.7 to 1.8 g weed dry weights of perennial weeds (Table 2).

**Table 1.** Percent control and influence of foramsulfuron OD and Flazasulfuron WP on dry weight of annual weeds in Korean lawn grass.

Treatments (dose <sup>a</sup> )	Annual weeds <sup>b</sup>			
	ERCA	DICI	CYAM	POAN
Dry weight (g)				
Foramsulfuron (46 g)	0.9	0.8	1.0	1.0
Flazasulfuron WP (75 g)	1.5	0.7	1.2	0.9
Untreated control	10.3	7.1	9.7	8.4
Weed control value (%)				
Foramsulfuron (46 g)	90.3 a <sup>c</sup>	89.9 a	89.3 a	88.8 a
Flazasulfuron WP (75 g)	85.2 a	89.0 a	82.9 a	90.3 a

<sup>a</sup> Dose unit = g a.i. ha<sup>-1</sup>.

<sup>b</sup> ERCA = *Erigeron canadensis*, DICI = *Digitaria ciliaris*, CYAM = *Cyperus amuricus*, POAN = *Poa annua*.

<sup>c</sup> Means within columns followed by the same letter were not significantly different at P = 0.05.

**Table 2.** Percent control and influence of foramsulfuron OD and Flazasulfuron WP on dry weight of perennial weeds in Korean lawn grass.

Treatments (dose <sup>a</sup> )	Perennial weeds <sup>b</sup>		
	TAPL	ARPR	TRRE
Dry weight (g)			
Foramsulfuron (46 g)	0.9	0.5	2.6
Flazasulfuron WP (75 g)	1.3	0.7	1.8
Untreated control	7.8	21.0	15.6
Weed control value (%)			
Foramsulfuron (46 g)	89.1 a <sup>c</sup>	94.8 a	88.3 a
Flazasulfuron WP (75 g)	84.0 a	94.1 a	90.0 a

<sup>a</sup> Dose unit = g a.i. ha<sup>-1</sup>.

<sup>b</sup> TAPL = *Taraxacum platycarpum*, ARPR = *Artemisia princeps*, TRRE = *Trifolium repens*.

<sup>c</sup> Means within columns followed by the same letter were not significantly different at P = 0.05.

**Phytotoxicity** Evidence of phytotoxicity in Korean lawn grass varied depending upon the regions, and some evidence was seen at 10, 20 and 30 DAT, however all plants recovered by 40 days after treatment.

**Table 3.** Phytotoxicity of foramsulfuron OD application on Korean lawn grass at five sites (0 = no injury, 9 = killed).

Year	Region	10 DAT <sup>a</sup>		20 DAT		30 DAT		40 DAT	
		1x <sup>b</sup>	2x	1x	2x	1x	2x	1x	2x
2010	Yeoju	0	0	0	0	0	0	0	0
2010	Gunpo	1	2	1	1	0	0	0	0
2011	Goyang	1	1	1	2	1	2	0	0
2011	Yeoju	0	0	0	0	0	0	0	0
2011	Jinju	1	1	1	2	1	1	0	0
2011	Anseong	0	0	0	0	0	0	0	0

<sup>a</sup> DAT = days after treatment.

<sup>b</sup> 1x = 46 g a.i. ha<sup>-1</sup>, 2x = 96 g a.i. ha<sup>-1</sup>.

## DISCUSSION

This study found foramsulfuron provides effective control (>88%) of some annual and perennial Korean lawn grass weeds, including *Erigeron canadensis*, *Digitaria ciliaris*, *Cyperus amuricus*, *Poa annua*, *Taraxacum platycarpum*, *Artemisia princeps* and *Trifolium repens*. Despite early evidence of phytotoxicity, Korean lawn grass fully recovered by 40 DAT. Therefore, foramsulfuron may be useful in general weed control in Korean lawn grass.

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