SELECTIVITY OF PROFOXYDIM AND METAMIFOP ON RICE VARIETIES AT THE EASTERN REGION OF URUGUAY

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ABSTRACT

Herbicides that inhibitor acetyl-coenzyme A carboxylase (ACCase) had started to be used to control herbicide-resistant barnyardgrass (*Echinochloa crusgalli*) in Uruguay. It is worthy to assess selectivity of profoxydim and metamifop on new varieties of rice recently released. A field experiment was conducted at the Experimental Unit of Paso de la Laguna in 2016-17 and 2017-18. In trial E1, rice plants were at two to four leaf-stage, and in trial E2, half of them were at tillering-stage when sprayed. Treatments evaluated were a factorial combination of variety and herbicide treatment. Two *indica* subtype (INIA Olimar and INIA Merín) and one tropical *japonica* subtype (Parao) were used. Herbicide treatments included a check without herbicide, 75 and 150 g ha^{-1} of metamifop, and 100 and 200 g ha^{-1} of profoxydim for E1, instead 100 and 200 g ha^{-1} of metamifop, 175 and 350 g ha^{-1} of profoxydim plus a check without herbicide for E2. Treatments were under a CRBD with three replications. A transient stunted growth in INIA Olimar was detected just in 2017-18 due to profoxydim but there was no rice yield reduction for any of the varieties evaluated neither in trial E1 nor in trial E2.

Key words: rice subtype, variety, ACCase inhibitor, weather conditions, herbicide injury

1. Introduction

Herbicides, inhibitors of acetyl-coenzyme A carboxylase (ACCase), like cyhalofop-butyl and metamifop of the aryloxyphenoxypropionate (AOPP), and profoxydim of the cyclohexanediones (CHD) had been used to control herbicide-resistant barnyardgrass. Since 2004, the percentage of i*ndica* subtype rice decrease from 80 to 65%, instead tropical *japonica* subtype increased slightly up to 20%. Most of the remaining acreage was seeded with temperate *japonica* subtype rice (Molina, et al., 2019). At field-scale in 2001, profoxydim injured severely El Paso 144 (*indica* subtype) (Deambrosi and Bonilla, 2002). When tested at small plot-scale trials in 2002, INIA Olimar (*indica* subtype) lost yield at the higher rate of profoxydim, while INIA Tacuarí (tropical *japonica* subtype) was not affected (Saldain and Deambrosi, 2003). In other trials, most of the plants of INIA Olimar died, showing less tolerance to profoxydim than EL Paso 144 and INIA Tacuarí (Figure 1, Com. Pers. Deambrosi and Saldain, 2004). Plants of CL212 (*indica* subtype), a blast disease (*Pyricularia oryzae*) resistant variety, died particularly when there were at four leaf-stage on postemergence spraying (Figure 2, Saldain and Sosa, 2017). This experiment was aimed to determine the selectivity of profoxydim and metamifop on high productivity and blast disease resistant new rice varieties like Parao (tropical *japonica* subtype) and INIA Merín (*indica* subtype).

2. Material and Methods

A field experiment was conducted during 2016-2017 and 2017-2018 rice seasons at the Experimental Unit of Paso de la Laguna (UEPL), Treinta y Tres, Uruguay. In the trial E1 herbicide treatments were applied on early postemergence at two to four-leaf stage of rice plants, while in trial E2, herbicide spraying was done when half of them was at tillering-stage. Treatments assessed came

from a factorial (Table 1) and they were layout under a CRBD with three replications. In Table 2, dates of main field activities are showed for both trials. Statistical analysis was done using Mixed procedure of SAS (Statistical Analysis System v9.4) and Dunnett test was used to pairwise comparisons between
no herbicide treatment (check) and different levels of the factor herbicide treatment.

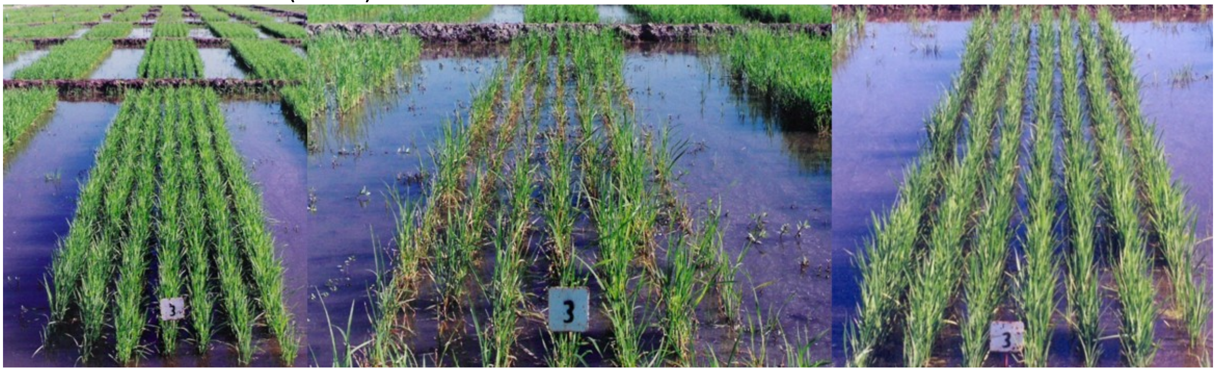

Figure 1. Rice injury observed when 140 g ha^{-1} of profoxydim was applied on rice plants at two to four leaf-stage. Left: El Paso 144 (*indica* subtype), Center: INIA Olimar (*indica* subtype) and Right: INIA Tacuarí (tropical *japonica* subtype). UEPL, 2003-2004.

Figure 2. Injury of profoxydim on CL212. Left: Differential tolerance between plants at tillering-stage and at leaf-stage when treated with 190 g ha^{-1} of profoxydim. Right: Central plot had profoxydim, and side plots were sprayed with 80 g ha^{-1} of metamifop. Río Branco, 2016-17.

Table 1. Varieties and herbicide treatments studied. UEPL, 2016-17 and 2017-18.

Factor		Dose, g ha^{-1}		Herbicide		Coadyuvant	
Variety	Herbicide	Trial E1	Trial E2	Product	g l^{-1}	Product	Dose
INIA Olimar	no herbicide	0	0	no	no	no	no
INIA Merín	metamifop	75 and 150	100 and 200	Metamifox	100	GRÜN ÖL	500 ml ha^{-1}
Parao	profoxydim	100 and 200	175 and 350	Aura®	200	DASH	0,5% v/v

Weed that survive were removed by hands doing three passes in both trials

Table 2. Field operations in rice selectivity experiment. UEPL, 2016-17 and 2017-18.

Field practices	Trial E1	Trial E2
Glyphosate on fallow land	3,5 l/ha de Glifoweed + 30 g/ha de Cerio	
Date of seeding rice	30-set-16, 11-oct-17	07-nov-16, 10-nov-17
Seeding density (viables seeds m^{-2})	485 in 2016 and 400 in 2017	
Date of spraying herbicide treatments	31-oct-16, 11-nov-17	07-dic-16, 13-dic-17
Flushing date	It was unnecessary	
Flooding date	14-nov-16, 23-nov-17	09-dic-16, 18-dic-17

3. Results and Discussion

When cold and cloudy days occurred simultaneously, severe injury of profoxydim was observed in 2001, 2002, and 2003. Those are a baseline data to contextualize the results obtained (Table 3). In both trials, no yield reduction was detected for any treatment (Tables 4 and 5). The stunted growth of INIA Olimar was transient and due to profoxydim on trial E1 in 2017. Although days were colder around spraying date than the baseline data, there is no severe injury. At the same time, those days were also sunnier, apparently preventing permanent injury and rice yield lost.

Table 3. Weather variables average ± standard deviation over 3 and 5 days around spraying date at the Experimental Unit of Paso de la Laguna, 2001-2003, 2016 and 2017.

Year of seeding	Temperatures (ºC) average	Temperatures (ºC) minimum*	Thermal amplitude, ºC	Relative heliophany, (%)	Rainfall event mm day^{-1}
3 days (± 1 day around spraying date)					
2001[(1)]	19.8 ± 2.0	10.6 ± 3.1	13.4 ± 4.7	45 ± 28	7.0
2002[(2)]	21.3 ± 0.8	16.2 ± 0.5	7.4 ± 2.0	38 ± 28	19.2, 1.8
2003[(3)]	20.4 ± 0.7	10.7 ± 1.7	12.7 ± 0.9	45 ± 22	0.5
2016 (E1)	19.8 ± 2.0	10.6 ± 3.1	13.4 ± 4.7	53 ± 40	40.3
2017 (E1)	17.2 ± 3.3	3.2 ± 3.1	20.3 ± 2.4	79 ± 1	-
2016 (E2)	21.3 ± 2.4	11.3 ± 2.8	14.9 ± 1.4	78 ± 14	-
2017 (E2)	22.5 ± 3.7	9.3 ± 7.7	18.7 ± 3.1	70 ± 12	-
5 days (± 2 days around spraying date)					
2001[(1)]	17.3 ± 3.8	9.1 ± 4.9	13.1 ± 4.3	48 ± 31	72.4
2002[(2)]	21.1 ± 1.4	14.6 ± 2.4	8.5 ± 2.1	37 ± 22	0.7
2003[(3)]	20.5 ± 0.6	10.6 ± 1.3	13.4 ± 1.5	61 ± 27	-
2016 (E1)	17.3 ± 3.8	9.1 ± 4.9	13.1 ± 4.3	61 ± 31	-
2017 (E1)	16.7 ± 2.4	4.0 ± 2.8	18.2 ± 3.8	73 ± 16	-
2016 (E2)	20.6 ± 3.4	9.4 ± 5.3	16.0 ± 2.9	78 ± 11	-
2017 (E2)	22.3 ± 3.5	9.1 ± 5.6	18.0 ± 3.8	75 ± 11	-

(E1)=Trial E1, (E2)=Trial E2, *=temperature minimum above 5 cm on turf, [(1)]=El Paso 144 severly injured (Deambrosi and Bonilla, 2002), [(2)]=INIA Olimar severly injured at the highest dose of profoxydim used (Deambrosi and Saldain, 2003), [(3)]=Plants of INIA Olimar dead by 140 g ha^{-1} of profoxydim at figure 1 (Com Pers. Deambrosi and Saldain, 2004)

4. Conclusions

Field study of herbicide selectivity needs to be repeated many years and locations to identify appropriately weather conditions promoting herbicide injury and its association with rice subtype and variety on productivity.

5. References

Deambrosi, E., Bonilla, O. III.3. Resultados de producción arroz. In: Unidad de Producción Arroz-Ganadería (UPAG). Resultados 2001-2002. Montevideo (UY): INIA, 2002. p.12-14. (INIA Actividad de Difusión; 293)

Molina F, Terra, J.A. and Roel. A. Evolución de algunas variables tecnológicas en el cultivo de arroz. In: Terra, J. A.; Martínez, S.; Saravia, H. (Eds.) Arroz 2019. Montevideo (UY): INIA, 2019. p. 1-3. (INIA Serie Técnica; 250)

Saldain, N.E., Deambrosi, E. Selectividad de herbicidas para capín (*Echinochloa* spp.) en variedades de arroz en el este del Uruguay. In: Congreso Latinoamericano de Malezas, 16 Y Congreso Nacional de la Asociación Mexicana de la Ciencia de la Maleza, 24. 2003, Manzanillo, Colima, México. Memoria. Manzanillo, Colima, ASOMECIMA, 2003.

Saldain, N.E., Sosa, B. ¿Cómo reducir los escapes de capín en sistemas intensivos en el uso de arroces Clearfield®? In: Zorrilla, G.; Martínez, S.; Terra, J. A. Saravia, H. (Eds.) Arroz 2018. Montevideo (UY): INIA, 2018. p. 58-60. (INIA Serie Técnica; 246)

Table 4. Effect of the interaction among year*variety*herbicide treatment on selected variables and rice yield adjusted by milling quality in trial E1 at UEPL.

Year of seeding	Variety	Herbicide treatment	Dose g ha^{-1}	Plants m^{-2}	Plant height, cm plant^{-1} 15 DAS	30 DAS	Flowering date	Panicles m^{-2}	1000-grains weight, g	Rice yield kg ha^{-1}
2016	INIA Olimar	No herbicide	0	178 a	12.0 a	31.1 a	30-ene. a	575 a	28.2 a	10205 a
		metamifop	75	186 a	13.0 a	32.5 a	28-ene. a	497 a	28.2 a	10902 a
		metamifop	150	140 a	12.4 a	32.7 a	29-ene. a	562 a	28.4 a	9755 a
		profoxidim	100	188 a	12.6 a	32.9 a	28-ene. a	523 a	28.7 a	10514 a
		profoxidim	200	170 a	11.8 a	32.0 a	30-ene. a	516 a	28.3 a	10729 a
	INIA Merín	No herbicide	0	178 a	12.4 a	32.8 a	3-feb. a	621 a	27.6 a	11735 a
		metamifop	75	191 a	11.4 a	30.7 a	4-feb. a	513 a	27.6 a	13069 a
		metamifop	150	208 a	11.7 a	29.9 a	4-feb. a	624 a	27.7 a	12431 a
		profoxidim	100	184 a	11.5 a	31.8 a	5-feb. a	637 a	28.1 a	12738 a
		profoxidim	200	180 a	10.8 a	27.6 b	5-feb. a	608 a	27.8 a	10824 a
	Parao	No herbicide	0	293 a	11.7 a	26.5 a	29-ene. a	611 a	28.7 a	12394 a
		metamifop	75	264 a	12.1 a	26.7 a	26-ene. b	464 a	28.8 a	10391 a
		metamifop	150	265 a	11.6 a	27.5 a	26-ene. b	552 a	28.7 a	10936 a
		profoxidim	100	253 a	12.3 a	28.5 a	28-ene. a	598 a	28.8 a	11114 a
		profoxidim	200	267 a	10.7 a	26.8 a	28-ene. a	618 a	28.9 a	11820 a
2017	INIA Olimar	No herbicide	0	187 a	20.5 a	47.3 a	29-ene. a	701 a	28.5 a	10416 a
		metamifop	75	223 a	20.5 a	46.7 a	30-ene. a	651 a	28.5 a	10546 a
		metamifop	150	203 a	20.2 a	48.9 a	29-ene. a	616 a	28.5 a	10770 a
		profoxidim	100	163 a	17.1 b	48.4 a	31-ene. a	553 a	29.0 a	9528 a
		profoxidim	200	157 a	16.9 b	48.0 a	2-feb. b	525 b	28.9 a	10415 a
	INIA Merín	No herbicide	0	215 a	15.9 a	45.2 a	9-feb. a	688 a	26.7 a	12508 a
		metamifop	75	195 a	16.1 a	42.8 a	8-feb. a	647 a	26.9 a	11167 a
		metamifop	150	198 a	16.4 a	44.5 a	8-feb. a	623 a	26.9 a	10768 a
		profoxidim	100	185 a	15.3 a	42.2 a	9-feb. a	610 a	26.7 a	10846 a
		profoxidim	200	231 a	15.8 a	42.4 a	9-feb. a	603 a	27.0 a	11366 a
	Parao	No herbicide	0	163 a	15.8 a	35.4 a	29-ene. a	492 a	27.0 a	9691 a
		metamifop	75	210 a	16.7 a	35.6 a	29-ene. a	538 a	27.8 a	10983 a
		metamifop	150	193 a	16.7 a	36.0 a	29-ene. a	521 a	27.8 a	11437 a
		profoxidim	100	233 a	15.7 a	36.0 a	29-ene. a	551 a	28.1 b	10678 a
		profoxidim	200	228 a	15.5 a	35.4 a	29-ene. a	529 a	27.4 a	10672 a
Dunnett$_{0,05}$				78	2.4	3.4	2 days	156	0.9	2363

DAS=days after spraying

Table 5. Effect of the interaction between variety*herbicide treatment on selected variables and rice yield (averaged over year) adjusted by milling quality in trial E2. UEPL in 2016-17 and 2017-18.

Variety	Herbicide Treatment	Dose g ha^{-1}	Tillers m^{-2}	Plant height, cm plant^{-1} 15 DAS	30 DAS	Flowering date	Panicles m^{-2}	1000-grains weight, g	Rice yield kg ha^{-1}
INIA Olimar	No herbicide	0	747 a	39.6 a	64.0 a	15-feb. a	634 a	26,8 a	11375 a
	metamifop	100	732 a	41.8 a	64.3 a	16-feb. a	665 a	26,7 a	11757 a
	metamifop	200	730 a	40.6 a	65.3 a	17-feb. a	591 a	26,9 a	11371 a
	profoxidim	175	747 a	39.4 a	64.9 a	16-feb. a	693 a	26,9 a	11747 a
	profoxidim	350	757 a	39.4 a	63.8 a	17-feb. a	604 a	26,7 a	11690 a
INIA Merín	No herbicide	0	752 a	37.2 a	59.7 a	27-feb. a	634 a	26,8 a	10429 a
	metamifop	100	746 a	39.1 a	59.1 a	26-feb. a	626 a	27,1 a	12396 b
	metamifop	200	734 a	38.7 a	61.0 a	28-feb. a	578 a	26,9 a	10498 a
	profoxidim	175	732 a	38.7 a	62.7 b	27-feb. a	616 a	27,0 a	11224 a
	profoxidim	350	746 a	37.7 a	61.3 a	27-feb. a	701 a	26,9 a	11257 a
Parao	No herbicide	0	641 a	30.8 a	52.2 a	18-feb. a	593 a	26,8 a	11883 a
	metamifop	100	592 a	34.0 a	53.3 a	17-feb. a	542 a	24,9 b	11562 a
	metamifop	200	643 a	32.8 a	52.3 a	18-feb. a	569 a	25,3 b	12373 a
	profoxidim	175	613 a	32.6 a	53.7 a	19-feb. a	567 a	25,7 b	12294 a
	profoxidim	350	560 a	31.4 a	52.4 a	18-feb. a	601 a	25,9 b	12604 a
Dunnett$_{0,05}$			139	2.2	3.7	4.8	128	0.7	1123

DAS=days after spraying