Omonrice 15: 63-67 (2007)

STUDY ON WEED AND WEEDY RICE CONTROL BY IMIDAZOLINONE HERBICIDES IN CLEARFIELD^{TM} PADDY GROWN BY IMI- TOLERANCE INDICA RICE VARIETY

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ABSTRACT

Two experiments with two types of rice culture , dry- seeded and wet- seeded rice, were carried out at the Experimental Farm of the Cuulong Delta Rice Research Institute (CLRRI) in Vietnam during Spring-Summer and Summer- Autumn seasons of 2006. The tested variety was OM5749-5, an indica rice genotype developed by plant breeders at CLRRI by crossing between a promising Vietnamese indica rice with IMI-tolerance japonica rice from Louisiana State University, USA. The tested herbicides are: imazapic, imazapyr, imazapic+imazapyr and imazethapyr+imazapyr. Results revealed that common weeds observed in the experimental field including Echinochloa crus- galli, Leptochloa chinensis, Cyperus iria, Cyperus difformis, Ludwigia octovalvis and especially weedy rice (Oryza sativa) were controlled successfully by the herbicides. The density and dry weight of weeds were brought down significantly as compared to those under untreated check. In dry seeded rice, the average rice grain yield of six imidazolinone treatments is 1.83 t/ha, 101.1% higher than check (0.91 t/ha). The corresponding data in wet-seeded rice are 2.15 t/ha and 0.88 t/ha with 143.9% increment. Rice quality is also improved by the treatments. The number of contaminated weedy rice seeds in rice product, seeds dropped in the soil surface, the percentage of red grains in milled rice is also reduced under herbicide treatments as compared to that of check statistically.

Keywords: Clearfield^{TM} paddy, herbicide tolerant variety, imidazolinone, weedy rice control

INTRODUCTION

Weedy rice, commonly considered as ecotypes of *Oryza sativa*, is a new pest in rice growing countries in the world including Vietnam. In tropical areas, weedy rice is progenies of crosses between wild rice and cultivated rice or come from degradation of cultivated rice varieties. The major characteristic of weedy rice is easy shattering. Other characteristics are observed as taller plants, fewer tillers, and high percentage of red rice in milled rice (Chin *et al.* 2000). Weedy rice competes with cultivated rice for sunlight, water and nutrients resulting in reduction in rice yield. The quality of milled rice is reduced due to contaminated red rice. Weedy rice infestation in rice fields is dangerous because seeds in seed bank increase over time with self-regeneration and there is no effective selective herbicide for controlling weedy rice. Recently, a new option for controlling weedy rice and also common weeds in rice fields has been initiated by exploring the integration of imidazolinone herbicides and tolerant trait containing variety (which is called CLEARFIELD ^{TM} rice). Imidazolinone herbicides controls weeds by inhibiting the plant specific enzyme acetohydroxyacid synthase (AHAS), which is involed in the biosynthesis pathway of the branched-chain amino acids as valine, leucine and isoleucine. This inhibition causes a disruption of protein synthesis, which interferes DNA synthesis and cell growth (Shanner and Connor 1991). CLEARFIELD^{TM} rice has been developed by Louisiana State University Agricultural Center breeders through a combination of mutagenesis and conventional plant breeding, which is tolerant to imidazolinone herbicides. This is characterized as a non-GMO variety. In Vietnam, CLRRI plant breeders have successfully developed indica rice genotypes, which are tolerant to imidazolinone herbicides. The research aims at determining whether the integration of imidazolinone herbicides and tolerant trait in the genotypes can be used for controlling weedy rice and common weeds in rice fields

MATERIALS AND METHODS

Two experiments were conducted in clay soil lowland fields with good water supply in the Spring-Summer with dry seeded rice and Summer- Autumn with wet seeded rice of 2006 at the Experimental farm of CLRRI. Rice variety OM5749-5 is indica rice with IMI tolerance trait. The cultivar was bred by CLRRI plant breeders by crossing between a promising Vietnamese indica rice and IMI-tolerance japonica rice from Louisiana State University, USA. In dry seeded rice, 200 kg of cultivated rice seeds were mixed with 100 kg of weedy rice seeds and broadcasted randomly before incorporation into the soil surface. In wet seeded rice, 100 kgs of pre-germinated seeds were sown in line by drum seeder. Pre-germinated seeds of weedy rice at the rate of 100 kg /ha were broatcast randomly one day later. Field trials with plot size of 20m^2 were established using randomized complete block design with four replications and seven treatments. Three active ingredients of imazapic, imazapyr and imazethapyr were used as solo and ready-mix formulations at various dose rate from 100 to 120 g *a.i.*/ha . Herbicides were sprayed at 12 days after emergence (DAE) in dry seeded rice and 10 days after sowing (DAS) in wet seeded rice. Crop oil was added at 0.5% water volume as non-ionic surfactant.

RESULTS AND DISCUSSION

Herbicidal activity

The population of weedy rice, *Echinochloa crus-galli*, *Leptochloa chinensis*, *Cyperus iria* affected by treatments of imidazolinone herbicides have been presented in Table 1.

Table 1. Weed and weedy rice density (No.plants /m^2) at 70 days after emergence (DAE) as affected by treatments (CLRRI, 2006 Spring-Summer)

	Treatments	Weedy rice (*)	ECHCG	LEPCH	CYPIR
T1	Untreated check	182.7	12.0	22.0	17.3
T2	[Imazapic+imazapyr]@100	0.0	0.0	0.0	0.0
T3	[Imazapic+imazapyr]@110	0.0	0.0	0.0	0.0
T4	[Imazapic+imazapyr]@120	0.0	0.0	0.0	0.0
T5	Imazapyr@120	12.7	0.0	0.0	0.0
T6	[Imazethapyr+imazapyr]@120	0.0	14.0	0.0	3.3
T7	Imazapic@120	0.0	0.0	0.0	0.0
	LSD(0.05)	81.4	6.1	12.8	14.1

(*) Weedy rice (*Oryza sativa*); ECHCG:*Echinochloa crus-galli*; LEPCH:*Leptochloa chinensis*; CYPIR:*Cyperus iria*.

All herbicide treatments brought down weedy rice densities significantly as compared to that in untreated check (182.7 plants / m^2). All treatments were very effective in controlling *Echinochloa crus-galli* except treatment T6 [Imazethapyr+imazapyr]@120. There was no difference between the treatments with weedy check. The density of *Leptochloa chinensis* remained at level of 22 plants / m^2 in untreated check whereas in all herbicide treatments, this weed was killed completely. The same trend was observed in the case of *Cyperus iria*. The density of *Cyperus iria* was lower statistically under all treatments except T6 [Imazethapyr+imazapyr]@120. In this treatment the weed remained at the level of 3.3 plants /m^2.

Dry matter accumulation of weedy rice and some common weeds observed in the experimental fields at 70 DAE have been presented in the Table 2.

Table 2. Weed and weedy rice dry weight (g/m^2) at 70 DAE as affected by treatments (CLRRI, 2006 Summer-Autumn)

	Treatments	Weedy rice (*)	ECHCG	LEPCH	CYPIR
T1	Untreated check	269.7	35.9	7.7	26.6
T2	[Imazapic+imazapyr]@100	0.0	0.0	0.0	0.0
T3	[Imazapic+imazapyr]@110	0.0	0.0	0.0	0.0
T4	[Imazapic+imazapyr]@120	0.0	0.0	0.0	0.0
T5	Imazapyr@120	21.7	0.0	0.0	0.0
T6	[Imazethapyr+imazapyr]@120	0.0	8.0	0.0	12.0
T7	Imazapic@120	0.0	0.0	0.0	0.0
	LSD(0.05)	78.2	25.6	3.5	3.1

All imidazolinone – herbicide treatments caused the reduction of weedy rice and weed dry weights statistically as compared to untreated check (269 g/m^2). However, the treatment of T5 [Imazapyr]@120 could not control weedy rice completely resulting in the remaining weedy rice dry weight of 21.7 g. /m^2. The *Echinochloa crus-galli* also was controlled successfully by all tested herbicides. However, some plants of this weed remained in the treatment of T6 [Imazethapyr+imazapyr]@120 resulting in the dry accumulation of 8.0 g/m^2. *Leptochloa chinensis* was controlled completely by all treatments. Dry weights of *Cyperus iria* were brought down significantly under all treatments as compared to untreated check (26.6 g./m^2) but the weed dry weight remained 12 g/m^2 under treatment of T6 [Imazethapyr + imazapyr]@120.

Yield components and grain yield

The imidazolinone herbicides successfully controlled weedy rice and common weeds in rice fields and therefore the competition of weeds on rice plants was minimized and rice plants can grow better as compared with that under untreated plots. The data on yield components and grain yields as affected by treatments have been presented in Table 3.

Table 3. Yield components and yield of dry seeded rice as affected by treatments (CLRRI, 2006 Spring-Summer)

	Treatment	No. of panicle/m^2	No.filled grains /panicle	1000-grain weight (g.)	Yield (t/ha)
T1	Untreated check	286	51.1	26.6	0.9
T2	[Imazapic+imazapyr]@100	311	63.5	26.4	1.7
T3	[Imazapic+imazapyr]@110	323	62.1	26.7	1.9
T4	[Imazapic+imazapyr]@120	325	63.2	26.7	1.8
T5	Imazapyr@120	341	63.3	26.3	1.8
T6	[Imazethapyr+imazapyr]@120	345	62.6	26.4	1.8
T7	Imazapic@120	350	67.2	26.5	2.1
	LSD(0.05)	48	4.2	0.9	0.5

Three treatments of [Imazapic+ imazapyr]@100; 110 and 120 g *a.i.*/ha tended to cause the increment of the number of panicles/m^2 but had not reach the level of significance. The rest of the three treatments of T5 [Imazapyr]@120; T6 [Imazethapyr+imazapyr]@120 and T7 [Imazapic]@120 were superior to untreated check in terms of the increment of the number of panicles / m^2 statistically. All herbicide treatments caused the increment of the number of filled grain per panicle significantly as compared to that of untreated check (51.1 grains / panicle). The average of the increment was 24.7%. There was no significant difference of 1,000-grain weights amongst treatments. Rice yields under treated plots were significantly higher as compared to that of untreated check (0.9t/ha). However, each herbicidal treatment was equal with the other in terms of yield. On the average of all herbicide treatments, rice yield increased 106% as compared to untreated check.

In wet seeded rice

One wet seeded experiment with the same design and treatments was conducted during Summer-Autumn season of 2006.

The population of weedy rice affected by herbicide treatments observed at 28, 56 and 84.

DAS have been presented in Table 4.

Table 4. Density (No.plants /m^2) of weedy rice at 28; 56 and 84 days after sowing (DAS) as affected by treatments (CLRRI, 2006 Summer-Autumn)

	Treatments	Weedy rice density (No.plants /m^2)		
		28 DAS	56 DAS	84 DAS
T1	Untreated check	69.3	245	246
T2	[Imazapic+imazapyr]@100	0.3	0	0
T3	[Imazapic+imazapyr]@110	5.0	0	0
T4	[Imazapic+imazapyr]@120	0.4	0	0
T5	Imazapyr@120	10.3	0	0
T6	[Imazethapyr+imazapyr]@120	1.8	0	0
T7	Imazapic@120	0.0	0	0
	LSD(0.05)	11.4	28	28

At 28 DAS, the density of weedy rice was 69.3 plants /m^2 in untreated check. All herbicide treatments brought down the population of weedy rice at 28 DAS significantly as compared with that of check. However, some plants of weedy rice were countable at this stage because the remaining weedy rice showed the symptoms of injury but have not been killed completely yet. At 56 and 84 DAS, all weedy rice plants were susceptible and completely killed. In the case of no spraying imidazolinoe herbicides, weedy rice grew normally and reached the density of 245-246 plants /m^2 at 56 DAS and 84 DAS, respectively.

The yield components and grain yields of wet seeded rice as affected by treatments have been presented in Table 5.

Table 5. Yield components and grain yield as affected by treatments (CLRRI, 2006 Summer-Autumn)

	Treatments	No.panicle/ m^2	No.filled grains/panicle	1,000-grain weight (g)	Yield (t/ha)
T1	Untreated check	142	57.4	26.5	0.88
T2	[Imazapic+imazapyr]@100	301	62.6	26.5	2.22
T3	[Imazapic+imazapyr]@110	339	76.7	27.2	2.25
T4	[Imazapic+imazapyr]@120	317	66.6	25.7	2.15
T5	Imazapyr@120	292	71.7	26.0	2.05
T6	[Imazethapyr+imazapyr]@120	316	66.5	27.1	2.13
T7	Imazapic@120	294	70.2	26.5	2.08
	LSD(0.05)	46	16.7	2.1	0.48

All the imidazolinone herbicide treatments caused the increments of the number of panicles / m^2 significatly as compared with untreated check (142 panicles /m^2). The number of panicles / m^2 in treatment T3 [Imazapic+imazapyr]@110 was the highest (339 panicles /m^2) and higher than T5 [Imazapyr]@120 statistically (292 panicles/m^2). However, treatment T3 [Imazapic+imazapyr]@110 was not higher than the rest of the other herbicide treatments. The average data of six treatments was 310 panicles /m^2 and increased 118% as compared to untreated check. The 1,000-grain weights were unchanged amongst all treatments including check. Rice grain yields under all herbicide treatments were superior to that of untreated check (0.88 t/ha) significantly. There was no significant difference amongst herbicide treatments. The average yield of 6 treated plots was 2.15 t/ha which increased 144 % as compared to untreated check (0.88 t/ha).

ACKNOWLEDGEMENT

Thanks are due to BASF Corporation, USA for granting the research funds and supporting other activities.

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Nghiên cứu phòng trừ cỏ dại và lúa cỏ bằng imidazolinone bằng cách trồng giống lúa Clearfield™ có gen chống chịu IMI

Viện Lúa ĐBSCL thực hiện 2 thí nghiệm sạ khô và sạ ướt trên giống lúa OM5749-5 do Viện lai tạo từ vật liệu indica với vật liệu đột biến gen IMI của Đại học Loisiana State. Các nghiệm thức xử lý với thuốc cỏ: imazapic, imazapyr, imazapic+imazapyr và imazethapyr+imazapyr. Kết quả cho thấy các loài cỏ dại *Echinochloa crus- galli*, *Leptochloa chinensis*, *Cyperus iria, Cyperus difformis, Ludwigia octovalvis* và lúa cỏ (*Oryza sativa*) đều bị chết do sử dụng các loại thuốc này. Trong kỹ thuật sạ khô, năng suất trung bình tăng 1,83 t/ha (101,1% hơn đối chứng) (0,91 t/ha). Trong kỹ thuật sạ ướt, năng suất 2.15 t/ha và 0.88 t/ha so với ĐC tăng 143.9%.