An Evaluation of Clearfield Rice Production on a Stale Seedbed

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ABSTRACT

Red rice (*Oryza sativa* L.) is the most troublesome weed in rice in the southern United States. It is the same genus and species as commercial rice varieties, and there have been no selective herbicides developed to control red rice in an established rice crop until Clearfield rice was commercialized by BASF in 2002. Clearfield rice is tolerant to the herbicide Newpath (imazethapyr), and Newpath provides very effective control of red rice and other important rice weeds. A study was conducted in Louisiana in 2000 and 2001 to compare the Clearfield rice system and the Newpath herbicide with a standard variety and an Arrosolo (propanil plus molinate) herbicide program in drill-seeded conventional and stale seedbeds. Newpath was applied sequentially with preemergence and postemergence applications. Rates were 0.063 lbs acre^{-1} followed by 0.063 lbs acre^{-1} or 0.094 lbs acre^{-1} followed by 0.032 lbs acre^{-1}. Arrosolo was also applied sequentially with early postemergence and late postemergence applications at a rate of 3.0 lbs acre^{-1} followed by 3.0 lbs acre^{-1}. An unsprayed weedy check was included for each system. Grain yields were not affected by tillage either year. In 2000, control of barnyardgrass (*Echinochloa crus-galli* L.), annual sedge (*Cyperus compressus* L.), and broadleaf signalgrass [*Bracharia platyphylla* (Griseb.) Nash] were similar for the Newpath and Arrosolo programs. Grain yields were also similar, and all herbicide programs significantly outyielded the unsprayed weedy controls. In 2001, weed infestations were minimal, and grain yields were similar for both herbicide programs and the weedy controls. Low levels of weed infestations affected net returns above direct production costs, and in 2000, yield increases due to weed control were not large enough to cover herbicide and application costs in the conventional tillage system with either herbicide program. With the stale seedbed, both herbicide programs increased returns above costs, and net returns exceeded the weedy checks. In 2001, neither herbicide program provided returns above those of the weedy checks, regardless of tillage. This study suggests that herbicide-tolerant rice technology, such as the Clearfield system, will be most beneficial in situations where difficult-to-control weeds, such as red rice, need to be managed. Herbicide programs need to be tailored to crop needs in either system to maximize production and increase net returns above costs.

KEYWORDS

Newpath, Arrosolo, barnyardgrass, red rice, herbicide tolerance

INTRODUCTION

Herbicide-tolerant rice technology is now a reality with the commercialization of Clearfield rice by BASF. Clearfield rice is tolerant to the herbicide Newpath, whereas red rice and numerous other common rice weeds are not. This system reflects a significant advancement in rice weed control, especially in red rice control, since it provides for the first time an opportunity to control red rice in established commercial rice. This will allow rice cultural systems to shift from predominantly water seeding to drill seeding, and this change is expected to mitigate environmental concerns associated with water-seeded production practices (Feagley *et al*., 1992). There is also potential for increased stale seedbed acreage with this system. Concerns with Clearfield rice include lower yield potential than the more popular standard varieties (Bollich *et al*., 2000; Bollich *et al*., 2001), increased production costs due to the new technology (higher seed costs and herbicide costs), the need for companion herbicides to broaden the weed spectrum of Newpath (Dillon *et al*., 2000; Pellerin *et al*., 2001a; Pellerin *et al*., 2001b; Masson and Webster, 2001), and the feasibility of Clearfield rice production when red rice is not a yield limitation.

The objective of this study was to compare a Clearfield rice system and Newpath herbicide with a standard variety and an Arrosolo herbicide program in drill-seeded conventional tillage and stale seedbed systems.

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MATERIALS AND METHODS

An experiment was conducted in Crowley, LA, at the Rice Research Station in 2000 and 2001 on a Crowley silt loam (Typic Albaqualf, fine, montmorillonitic, thermic). A randomized complete block with a factorial arrangement of two tillage systems, five herbicide treatments (including an untreated weedy control for each herbicide system), and four replications were used. Conventional tillage was compared with a stale seedbed in a drill-seeded cultural system. Phosphorus and potassium (60 lbs acre^{-1} each) were incorporated in the fall, and conventional and stale seedbeds were completely tilled prior to establishment of each rice crop. The test area was allowed to become stale over the winter months. One month prior to seeding, the stale seedbed was sprayed with 1 qt acre^{-1} Roundup (1.0 lbs ai acre^{-1}) and 2 pt acre^{-1} (1.0 lbs ai acre^{-1}) 2,4-D to terminate winter vegetation. The conventional seedbed was again tilled in the spring immediately before planting. An Arrosolo herbicide system with a standard variety was compared with a Clearfield variety and Newpath herbicide. Cypress and Cocodrie were planted as the standard varieties in 2000 and 2001, respectively. In the Clearfield system, CF501 and CL141were planted as the herbicide-tolerant varieties in 2000 and 2001, respectively. Arrosolo herbicide was applied as a sequential treatment of 2 qt acre^{-1} (3.0 lbs ai acre^{-1}) early postemergence (EP) plus 2 qt acre^{-1} late postemergence (LP) to the standard varieties. Newpath herbicide was applied sequentially as a 4 oz acre^{-1} (0.063 lbs ai acre^{-1}) preemergence (Pre) plus 4 oz acre^{-1} postemergence (Po), and sequentially as a 5 oz acre^{-1} (0.094 lbs ai acre^{-1}) Pre plus 3 oz acre^{-1} (0.032 lbs ai acre^{-1}) Po to the Clearfield varieties. The experiment was flush irrigated as needed until the 4-leaf growth stage. Nitrogen (165 lbs acre^{-1}) as urea was surface applied, and a permanent flood was established 1 to 2 days later. After main crop harvest and additional 75 lbs acre^{-1} nitrogen was applied and the experiment was immediately flooded for ratoon crop production. Standard agronomic practices (insect and disease control) were conducted according to current recommendations. Weed control (barnyardgrass, broadleaf signalgrass, and annual sedge 5 weeks after seeding) and main crop and ratoon crop grain yields were determined. Data were analyzed using SAS anova procedures, and treatment means were separated using Fisher's Protected LSD (P = 0.05). Returns above costs for herbicide treatments were estimated for each tillage system each year and were based on a tenant share arrangement.

RESULTS AND DISCUSSION

Weed control ratings for 2000 are shown in Table 1. Barnyardgrass control was higher with conventional tillage

Table 1. Influence of tillage and herbicide program on weed control in Clearfield and Cypress rice for the 2000 crop year. The tillage x herbicide interaction was non-significant (P = 0.05) for every response variable.

		Barnyardgrass		Signalgrass		Annual sedge	
Herbicide program	Rate/timing†	Conv	Stale	Conv	Stale	Conv	Stale
	------ lbs acre^{-1} ------	---------- % control ----------					
Arrosolo	3.0 EP + 3.0 LP	95	68	95	83	95	86
Newpath	0.063 Pre + 0.063 Po	95	93	95	95	95	94
Newpath	0.094 Pre + 0.032 Po	95	70	95	71	95	71
Arrosolo check	--	11	0	11	0	11	0
Newpath check	--	0	0	0	0	0	0
C.V., %		34.0		32.0		31.7	
Tillage mean							
Conventional		59		59		59	
Stale		46		50		50	
LSD $_{(0.05)}$		12		ns		ns	
Herbicide mean							
Arrosolo	3.0 EP + 3.0 LP	81		89		91	
Newpath	0.063 Pre + 0.063 Po	94		95		94	
Newpath	0.094 Pre + 0.032 Po	83		83		83	
Arrosolo check	--	6		6		6	
Newpath check	--	0		0		0	
LSD $_{(0.05)}$		18		18		18	

†EP = early postemergence, LP = late postemergence, Pre = preemergence, Po = postemergence.

than with the stale seedbed, but control of broadleaf signalgrass and annual sedge were similar. There were no differences in weed control among the three herbicide programs for any of the weeds rated. All herbicide programs controlled weeds greater than 80%. Injury was observed with Arrosolo and Newpath but was less than 15% (data not shown). Grain yields were not influenced by tillage (Table 2). Arrosolo and the two Newpath treatments significantly increased grain yields over the unsprayed controls, and main crop grain yields were similar. Ratoon crop grain yields were significantly higher with Arrosolo and with the unsprayed Cypress control. These differences were due to the higher yield potential of Cypress and not weed control or injury. Total grain yield with Arrosolo was significantly higher than with Newpath only when Newpath was applied at a sequential rate of 5 oz followed by 3 oz. All herbicide programs significantly outyielded their respective unsprayed controls.

Weed control ratings for 2001 are shown in Table 3. Weed infestation levels were low in 2001. Although weed control was significantly higher with herbicide application when compared with the unsprayed controls, overall weed control was lower than in 2000. Tillage had no effect on weed control. Tillage also had no effect on grain yields (Table 4). Main crop, ratoon crop, and total grain yields were similar for all herbicide programs and the unsprayed controls. Lack of weed infestation resulted in no advantage in applying herbicides in 2001. Yield potential was also similar between the Clearfield variety CL141 and Cocodrie planted in 2001.

An economic analysis of results from the 2-year study was conducted and is shown in Table 5. Net returns per acre above direct production costs were estimated for both years of the study for a tenant rice producer paying a 30 percent crop share for land and water. Producer share of rice yields were valued in both years at the loan rate ($6.50 cwt^{-1}). Direct production costs per acre were estimated for the conventional tillage and stale seedbed production system and included expenses for seed, fertilizer, chemicals, custom application, fuel, labor, repairs, and interest on operating costs. Net returns were generally lower in the 2000 test compared with 2001 due to additional insecticide and fungicide treatments applied. Cost differences between the Clearfield production system and the standard Arrosolo herbicide program in the study were primarily related to herbicide material cost and seed cost. Herbicide material costs (excluding application charges) were approximately $30 acre^{-1} for the Newpath treatment compared with $26 acre^{-1} for the Arrosolo treatment. Rice seed costs for Clearfield were $46 cwt^{-1} compared with $16 cwt^{-1} for conventional Cypress and Cocodrie varieties. In tests conducted in 2000, the Arrosolo plots yielded higher

Table 2. Influence of tillage and herbicide program on grain yield (12% moisture) of Clearfield and Cypress rice for the 2000 crop year. The tillage x herbicide interaction was non-significant ($P = 0.05$) for every response variable.

		Main crop		Ratoon crop		Total	
Herbicide program	Rate/timing†	Conv	Stale	Conv	Stale	Conv	Stale
	------ lbs acre^{-1} ------	---------- lbs acre^{-1} ----------					
Arrosolo	3.0 EP + 3.0 LP	7241	7342	2475	2576	9716	9917
Newpath	0.063 Pre + 0.063 Po	7127	7731	1778	1954	8905	9685
Newpath	0.094 Pre + 0.032 Po	7463	7485	1772	1833	9235	9318
Arrosolo check	--	6676	6289	2543	2528	9219	8816
Newpath check	--	6945	6597	1733	1772	8678	8369
C.V., %		6.14		11.10		5.64	
Tillage mean							
Conventional		7091		2060		9151	
Stale		7089		2132		9221	
LSD $_{(0.05)}$		ns		ns		ns	
Herbicide mean							
Arrosolo	3.0 EP + 3.0 LP	7292		2525		9817	
Newpath	0.063 Pre + 0.063 Po	7429		1866		9295	
Newpath	0.094 Pre + 0.032 Po	7474		1802		9277	
Arrosolo check	--	6483		2535		9018	
Newpath check	--	6771		1752		8524	
LSD $_{(0.05)}$		446		239		532	

†EP = early postemergence, LP = late postemergence, Pre = preemergence, Po = postemergence.

Table 3. Influence of tillage and herbicide program on weed control in Clearfield and Cocodrie rice for the 2001 crop year. The tillage x herbicide interaction was non-significant ($P = 0.05$) for every response variable.

Herbicide program	Rate/timing†	Barnyardgrass		Signalgrass		Annual sedge	
		Conv	Stale	Conv	Stale	Conv	Stale
	------ lbs acre^{-1} ------	---------- % control ----------					
Arrosolo	3.0 EP + 3.0 LP	74	70	85	80	83	80
Newpath	0.063 Pre + 0.063 Po	79	75	85	80	85	83
Newpath	0.094 Pre + 0.032 Po	75	73	83	83	85	85
Arrosolo check	--	0	0	0	0	0	0
Newpath check	--	0	0	0	0	0	0
C.V., %		12.92		6.73		5.31	
Tillage mean							
Conventional		46		51		51	
Stale		44		49		50	
LSD $_{(0.05)}$		ns		ns		ns	
Herbicide mean							
Arrosolo	3.0 EP + 3.0 LP	72		83		81	
Newpath	0.063 Pre + 0.063 Po	77		83		84	
Newpath	0.094 Pre + 0.032 Po	74		83		85	
Arrosolo check	--	0		0		0	
Newpath check	--	0		0		0	
LSD $_{(0.05)}$		6		3		3	

†EP = early postemergence, LP = late postemergence, Pre = preemergence, Po = postemergence.

Table 4. Influence of tillage and herbicide program on grain yield (12% moisture) of Clearfield and Cocodrie rice for the 2001 crop year. The tillage x herbicide interaction was non-significant ($P = 0.05$) for every response variable.

Herbicide program	Rate/timing†	Main crop		Ratoon crop		Total	
		Conv	Stale	Conv	Stale	Conv	Stale
	------ lbs acre^{-1} ------	---------- lbs acre^{-1} ----------					
Arrosolo	3.0 EP + 3.0 LP	7647	6820	1697	1483	9344	8303
Newpath	0.063 Pre + 0.063 Po	6960	7208	1898	1871	8858	9080
Newpath	0.094 Pre + 0.032 Po	7134	7143	1741	1584	8875	8726
Arrosolo check	--	7238	7173	1880	1479	9118	8652
Newpath check	--	6659	7267	1860	1856	8519	9123
C.V., %		8.83		15.35		7.44	
Tillage mean							
Conventional		7128		1815		8943	
Stale		7122		1654		8777	
LSD $_{(0.05)}$		ns		ns		ns	
Herbicide mean							
Arrosolo	3.0 EP + 3.0 LP	7233		1590		8823	
Newpath	0.063 Pre + 0.063 Po	7084		1885		8969	
Newpath	0.094 Pre + 0.032 Po	7139		1662		8801	
Arrosolo check	--	7206		1679		8885	
Newpath check	--	6963		1858		8821	
LSD $_{(0.05)}$		ns		ns		ns	

†EP = early postemergence, LP = late postemergence, Pre = preemergence, Po = postemergence.

estimated net returns above direct costs per acre than the Clearfield plots due primarily to significant yield differences, as well as the higher seed and herbicide costs for the Clearfield system. Yield increases from the application of Newpath herbicide were not large enough to cover herbicide and application costs in the conventional tillage test but did offset added costs in the stale seedbed tests, as net return for both Newpath treatments exceeded the check. In the 2001 tests, yield increases for both the Arrosolo and Newpath treatments were not large enough to offset additional herbicide treatment and application costs.

CONCLUSIONS

Weed infestations were moderate to very light in 2000 and 2001, respectively. There were few differences in weed control between herbicide programs and between tillage systems. Grain yields were significantly higher in 2000 when herbicides were applied; but in 2001, weed control had no effect on grain yields. In Louisiana, it is very uncommon to maximize both grain yield and net returns without a successful weed control program. Since the primary objective of this study was to compare two different weed control technologies, standard applications were made each year with no regard to weed infestation level. In 2001, especially since weed infestation levels were minimal, a single application of herbicide with the standard variety, and possibly a less expensive one, would have improved net returns in that system. With the Clearfield technology, Newpath is labeled specifically to be applied sequentially with two 4-oz applications. This is especially critical for red rice control. In commercial fields where red rice infestation are not yield limiting, it is questionable whether Clearfield technology will be profitable. With any rice weed control program, it is important to tailor the herbicides to weeds present and to consider weed size when determining both application rate and timing if high grain yields and maximum economic returns are expected.

Table 5. Net returns above direct production costs for conventional tillage and stale seedbed rice production with Clearfield and Arrosolo herbicide programs. Returns above costs assume that the tenant share of the rice yield (70%) is valued at loan rate ($6.50/cwt).

Herbicide program	Herbicide rate	Total grain yield	Returns above costs
		--- lbs acre^{-1} --	--- $ acre^{-1} ---
Conventional Tillage- 2000			
Newpath	0.063 Pre + 0.063 Post	8905	10.93
Newpath	0.094 Pre + 0.032 Post	9235	23.23
Newpath control	--	8678	42.44
Arrosolo	3.0 EP + 3.0 LP	9716	69.25
Arrosolo	--	9219	86.14
Stale Seedbed- 2000			
Newpath	0.063 Pre + 0.063 Post	9685	21.52
Newpath	0.094 Pre + 0.032 Post	9318	7.63
Newpath control	--	8369	3.38
Arrosolo	3.0 EP + 3.0 LP	9918	58.11
Arrosolo	--	8817	50.45
Conventional Tillage- 2001			
Newpath	0.063 Pre + 0.063 Post	8858	61.97
Newpath	0.094 Pre + 0.032 Post	8875	62.71
Newpath control	--	8519	89.37
Arrosolo	3.0 EP + 3.0 LP	9344	108.28
Arrosolo	--	9118	135.38
Stale Seedbed- 2001			
Newpath	0.063 Pre + 0.063 Post	9079	55.94
Newpath	0.094 Pre + 0.032 Post	8727	44.15
Newpath control	--	9123	100.89
Arrosolo	3.0 EP + 3.0 LP	8303	54.63
Arrosolo	--	8652	106.67

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