INFLUENCE OF COVER CROPS AND TILLAGE ON BARNYARDGRASS CONTROL AND RICE YIELD

D.L. Jordan[1] and P.K. Bollich[2]

[1]Northeast Research Station, Louisiana State University Agricultural Center, St. Joseph, LA 71366.
Current address: Dept. of Crop Science, North Carolina State University, Raleigh, NC 27695-7620. USA.

[2]Rice Research Station, Louisiana State University Agricultural Center, Crowley, LA 70527. USA.

Corresponding author's e-mail: david_jordan@ncsu.edu

ABSTRACT

Cover crops can improve weed control and soil tilth when used in reduced tillage systems. However, weed and crop response can vary. Reduced tillage rice (*Oryza sativa* L) production has gained considerable popularity in the mid-South production region of the United States. However, the role of cover crops in rice production systems has not been clearly established. Three experiments were conducted in Louisiana during 1995 and 1996 to compare barnyardgrass (*Echinochloa crus-galli* L.) control and rice grain yield when rice was drill seeded into desiccated wheat (*Triticum aestivum* L), oats (*Avena sativa* L.), cereal rye (*Secale cereale* L.), Italian ryegrass (*Lolium multiflorum* Lam.), Kentucky bluegrass (*Poa pratensis* L.), tall fescue (*Festuca arundinacea* Schreb.), crimson clover (*Trifolium incarnatum* L.), and hairy vetch (*Vicia villosa* L.). Conventional tillage and stale seedbed (native vegetation) systems were also included. Barnyardgrass control at harvest was less than 50% when in-season herbicides (herbicides applied after weed and rice emergence) were not applied regardless of the cover crop or tillage system. Italian ryegrass and tall fescue were the most suppressive cover crops, controlling barnyardgrass 45 to 49%. Suppression of barnyardgrass ranged from 6 to 21% for the cover crops wheat, oats, cereal rye, annual bluegrass, crimson clover, and hairy vetch. Conventional tillage and native vegetation (stale seedbed) controlled barnyardgrass 42 and 33%, respectively. In-season herbicides controlled barnyardgrass at least 86% regardless of the cover crop or tillage system, and increased yields for all systems except for the cover crops Italian ryegrass and tall fescue. When herbicides were not applied in-season, rice grain yield ranged from 560 lbs acre^{-1} to 2380 lbs acre^{-1} regardless of cover crop, with the only difference among cover crop or tillage systems existing between crimson clover (560 lbs acre^{-1}) and tall fescue (2380 lbs acre^{-1}). Rice yield ranged from 4100 to 4550 lbs acre^{-1} for conventional and stale seedbed systems and the cover crop cereal rye; 3670 to 3760 lbs acre^{-1} for wheat, oat, and annual bluegrass cover crops; and 1680 to 3170 lbs acre^{-1} for Italian ryegrass and tall fescue cover crops when in-season herbicides were applied.

KEYWORDS

Allelopathy, conventional tillage, cover crops, *Echinochloa crus-galli* (L.) Beauv., herbicide, stale seed bed, weed control

INTRODUCTION

Although rice in the United States is typically grown in conventionally tilled systems, reduced tillage systems can be a successful alternative to this energy-intense approach (Bollich and Feagley, 1994). Cover crops can suppress weed populations, and in some instances they can reduce reliance on in-season herbicides (Worsham, 1991; Yenish *et al*., 1996; Jordan *et al*., 1999). Success depends on a number of factors including the cover crop, weed spectrum and density, herbicide, and response of the crop (Burgos and Talbert, 1996; Yenish *et al*., 1996; Zadasa *et al*., 1997; Jordan *et al*., 1999). Determining weed and rice response to cover crops is important in determining if cover crops can be an effective management tool for rice production. Therefore, research was conducted during 1995 and 1996 in Louisiana to determine which cover crops were most effective in suppressing barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.] populations and if specific cover crops affect rice growth and grain yield.

MATERIALS AND METHODS

Experiments were conducted at the Northeast Research Station located near St. Joseph, LA in 1995 and 1996 and near the Macon Ridge Branch of the Northeast Research Station located at Winnsboro, LA in 1995.

Soils at St. Joseph and Winnsboro were a Sharkey clay (very fine, montmorrilonitic, nonacid, Vertic Haplaquepts) and a Gigger silt loam (fine-silt, mixed, thermic, Typic Fragiudalfs), respectively. During the fall prior to planting rice in the spring, test areas were disked twice, field cultivated, and precision leveled. Wheat, oats, cereal rye, Italian ryegrass, Kentucky bluegrass, tall fescue, crimson clover, and hairy vetch cover crops were established in

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October of 1994 and 1995. Grass cover crops were seeded at 100 lbs acre^{-1}. Crimson clover and hairy vetch were seeded at 35 lbs acre^{-1}. Additional treatments included conventional tillage and stale seedbed (native emerged winter and summer vegetation) systems.

Glyphosate (Roundup Ultra) at 0.75 lbs ae acre^{-1} was applied two weeks prior to seeding rice to control grass cover crops and emerged weeds in the stale seedbed system. Paraquat (Gramoxone Extra) at 0.125 lbs ai acre^{-1} was applied at this timing to control crimson clover and hairy vetch. A nonionic surfactant at 0.25% (v/v) was included with herbicides. The entire test area, other than the conventional tillage system, was treated with paraquat at 0.125 lbs acre^{-1} within two days prior to seeding rice. Conventional seedbeds were prepared with two passes of a vertical-action tiller set to a depth of four inches. The cultivar 'Cypress' was seeded at a rate of 100 lbs acre^{-1} using a drill with rows spaced eight inches apart with a single coulter establishing a narrow tilled zone prior to seed placement. In-season herbicide treatments for each cover crop and tillage system consisted of a no-herbicide control or a tank mixture of propanil plus molinate plus quinclorac (Arrosolo plus Facet) at 3.0 + 3.0 + 0.38 lbs ai acre^{-1}, respectively, applied one week prior to permanent flood establishment (approximately four weeks after rice emergence). Nitrogen at 150 lbs acre^{-1} (as urea) was broadcast two days prior to permanent flood establishment with the flood maintained until rice grain reached physiological maturity. Plot size was 6 by 25 feet.

Visual estimates of percent barnyardgrass control were recorded two days prior to permanent flood establishment and again two weeks prior to rice harvest using a scale of 0 to 100% where 0 = no control and 100% = complete control. The cover crop or tillage system with the poorest level of barnyardgrass control was assigned a value of 0, with all other treatments within that replication evaluated relative to that treatment. Chlorosis, necrosis, plant stunting, and stand reduction were used when making the visual estimates. Barnyardgrass density ranged from 50 to 200 plants per square yard. Native vegetation in the stale seedbed system consisted of annual bluegrass (*Poa annua* L.), little barley (*Hordeum pusillum* Nutt.), and buttercup (*Ranunculas* spp.). Rice grain was harvested when grain moisture was approximately 18%. Final grain moisture was adjusted to 12%.

The experimental design was a randomized complete block with a split plot arrangement of treatments. Tillage and cover crop systems served as main plots with in-season herbicide treatments serving as sub-plots. Data were subjected to analyses of variance for a ten (cover crop or tillage system) by two (in-season herbicide treatments) factorial treatment arrangement. Means for the interaction of tillage and the cover crop system by the in-season herbicide program for barnyardgrass control at a permanent flood establishment, prior to harvest and for rice grain yield were separated using Fisher's Protected LSD Test at P = 0.05.

RESULTS AND DISCUSSION

Barnyardgrass control and rice yield varied among cover crops, tillage systems, and between in-season herbicide programs. Therefore, the interaction of these treatment factors is presented for barnyardgrass control and rice grain yield (Table 1). In-season herbicides were generally needed to obtain satisfactory control of barnyardgrass and utlimately to optimize grain yield. The exception was barnyardgrass control at flood establishment when rice was seeded into desiccated Italian ryegrass. Control without in-season herbicides using this cover crop was 76%, and applying propanil plus molinate plus quinclorac prior to permanent flood establishment did not increase control. Although tall fescue controlled barnyardgrass similar to the control by Italian ryegrass (58% versus 76%) when in-season herbicides were not applied, control was improved by herbicides. Control by these cover crops exceeded that by stale seedbed systems and by wheat, crimson clover, and hairy vetch cover crops when herbicides were not applied. Control in conventional tillage, stale seedbeds, and wheat, oats, cereal rye, Kentucky bluegrass, tall fescue, and hairy vetch cover crops was similar. Control with crimson clover was the lowest (20%). Applying in-season herbicides increased control at permanent flood establishment to at least 96% regardless of cover crop or tillage system.

Barnyardgrass control at harvest was less than 50% regardless of the cover crop or tillage system when herbicides were not applied after rice planting (Table 1). Italian ryegrass and tall fescue were the most suppressive cover crops, controlling barnyardgrass 45 to 49%. Suppression of barnyardgrass ranged from 6 to 21% for the cover crops wheat, oats, cereal rye, Kentucky bluegrass, crimson clover, and hairy vetch. Conventional tillage and stale seedbed (native vegetation) systems controlled barnyardgrass 42 and 33%, respectively. Propanil plus molinate plus quinclorac controlled barnyardgrass at least 86% regardless of the cover crop or tillage system.

In-season herbicides increased yields for all systems except when rice was seeded into desiccated Italian ryegrass and tall fescue cover crops. When herbicides were not applied in-season, rice grain yield ranged from 560 lbs acre^{-1} to 2380 lbs acre^{-1} regardless of cover crop, with the only difference among cover crops or tillage systems existing between crimson clover (560 lbs acre^{-1}) and tall fescue (2380 lbs acre^{-1}). When in-season herbicides were applied, rice yield ranged from 4100 to 4550 lbs acre^{-1} for

Table 1. Barnyardgrass control and rice grain yield following planting in drill-seeded systems either with or without in-season herbicides depending upon cover crop selection and tillage system.†

Tillage system or cover crop	In-season herbicides‡	Barnyardgrass control§ Flood establishment	Barnyardgrass control§ Harvest	Rice yield
		%	%	lbs acre^{-1}
Conventional tillage	No	38 cde	42 bcd	1740 de
Conventional tillage	Yes	97 a	99 a	4980 a
Stale seedbed	No	30 de	33 be	1650 de
Stale seedbed	Yes	98 a	95 a	4780 a
Wheat	No	34 de	21 be	990 de
Wheat	Yes	98 a	89 a	3670 abc
Oats	No	39 cde	15 de	860 e
Oats	Yes	97 a	91 a	3760 abc
Cereal rye	No	39 cde	15 de	1390 de
Cereal rye	Yes	98 a	94 a	4720 a
Italian ryegrass	No	76 ab	45 bc	620 e
Italian ryegrass	Yes	98 a	97 a	1680 de
Kentucky bluegrass	No	45 cd	20 cde	1200 de
Kentucky bluegrass	Yes	97 a	94 a	3670 abc
Tall fescue	No	58 bc	49 b	2380 cd
Tall fescue	Yes	97 a	99 a	3170 bc
Crimson clover	No	20 e	20 cde	1350 de
Crimson clover	Yes	96 a	94 a	4100 ab
Hairy vetch	No	31 de	6 e	560 e
Hairy vetch	Yes	99 a	86 a	4550 ab
CV (%)	-	18	25	29

†Means within a column followed by the same letter are not significantly different according to Fisher's Protected LSD Test at $P = 0.05$. Data are pooled over three experiments.

‡In-season herbicides were a tank mixture of propanil plus molinate plus quinclorac (Arrosolo plus Facet) at 3.0 + 3.0 + 0.38 lbs acre^{-1}, respectively, applied postemergence approximately one week prior to permanent flood establishment.

§Early-season evaluations were recorded when the permanent flood was established approximately four weeks after rice emergence and one week after in-season herbicide applications. Late-season evaluations were recorded two weeks prior to harvest.

conventional and stale seedbed systems and the cover crop cereal rye, 3670 to 3760 lbs acre^{-1} for wheat, oat, and Kentucky bluegrass cover crops, and 1680 to 3170 lbs acre^{-1} for Italian ryegrass and tall fescue cover crops.

These data suggest that cover crops will not suppress barnyardgrass sufficiently to prevent reductions in rice yield when populations of barnyardgrass are relatively high in drill-seeded production systems. In-season herbicides were needed to control barnyardgrass adequately. Previous research (Jordan *et al*., 1999) suggested that establishing a wheat cover crop often resulted in a lower infestation of barnyardgrass after planting when compared with conventional tillage systems. Additionally, less barnyardgrass was noted in stale seedbed systems when compared with that of conventional tillage systems. However, in-season herbicides were still needed to optimize rice grain yield.

Italian ryegrass and tall fescue were among the cover crops that suppressed barnyardgrass the most; however, these cover crops reduced yields when barnyardgrass was controlled with in-season herbicides. While these cover crops most likely were reducing either nitrogen availability or suppressing rice growth through allelopathy, additional research is needed to define the exact mechanism. Previous research (Jordan *et al*., 1999) suggested that a desiccated wheat cover crop suppressed weed and rice growth in both water-seeded and dry-seeded rice production. Increasing the nitrogen rate did not sufficiently overcome poor rice growth that was associated with seeding rice into a desiccated wheat cover crop (Jordan *et al*., 2000).

These data also indicate that conventional tillage and stale seedbed systems were among the highest yielding systems when herbicides were applied in-season. Although cover crops are often promoted in reduced tillage systems, results from these experiments suggest that growers should carefully consider strengths and weaknesses of cover crops in rice production systems.

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