Influence of Tillage and Wheat Cover Crop on Herbicide Inputs in Rice *(Oryza sativa)*

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Abstract

Interest in producing rice under reduced-tillage systems has increased in the southern United States. Additionally, the extensive use of pesticides has been scrutinized and has resulted in a search for management practices that reduce pesticide inputs through the use of cultural practices and biological control mechanisms. Development of effective and cost-efficient weed management strategies will continue to be critical regardless of the control tactics involved. Research was conducted at the Northeast Research Station located near St. Joseph, LA, and at the Rice Research Station located near Crowley, LA, to evaluate the effects of tillage, a wheat cover crop, and in-season herbicide inputs on weed control and rice yields in both dry- and water-seeded systems. Barnyardgrass *(Echinochloa crusgalli)* and purple ammania *(Ammania coccinea)* were the predominant weed species in the dry- and water-seeded systems, respectively. A wheat cover crop suppressed barnyardgrass and purple ammania relative to conventional tillage and stale seedbed systems and showed potential for reducing in-season herbicide inputs. Rice yields generally increased as the level of in-season herbicide input was increased. Yields in conventional tillage and stale seedbed systems were similar.

Introduction

Concern about environmental quality and food quality issues has led to increased emphasis on developing alternative production systems which employ cultural practices that minimize surface and ground water pollution and reduce herbicide inputs (Feagly et al., 1992). Success with alternative production systems, especially in the major agronomic crops, has been somewhat erratic. A need for further evaluation of alternative cropping systems and pest management strategies is needed to develop both cost efficient and profitable production systems with minimal environmental impact.

Rice is traditionally grown under conventional-tillage systems with heavy reliance on herbicides for weed control. However, rice can be successfully produced in reduced-tillage systems (Bollich and Sanders, 1993). Research in other crops indicates that cover crops can suppress weeds, and, in some instances, may reduce the need for some herbicide inputs (Worsham, 1991). Limited data exist evaluating the interactions of tillage systems, cover crops, and herbicide inputs in rice. Therefore, experiments were conducted to evaluate weed control and rice yield with various tillage/cover crop systems with varying levels of in-season herbicides.

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Materials and Methods

Field experiments were conducted at the Northeast Research Station located near St. Joseph, LA (Sharkey silty clay soil) and at the Rice Research Station located near Crowley, LA (Crowley silt loam soil) to evaluate interactions among tillage practices, cover crop, and in-season herbicide inputs with respect to weed control and rice grain yield. Treatment factors within both dry- and water-seeded systems included three levels of tillage/cover crops [conventional (CT), stale seedbed (SB), and no-till with a wheat cover crop (WC)]. The entire test area was tilled in the fall and leveled. Wheat was established by planting 100 lb seed/A using a grain drill with 8-inch row spacings.

Winter and summer weeds and the wheat cover crop were controlled prior to rice emergence in the SB and WC systems with combinations of glyphosate, the amine formulation of 2,4-D, and paraquat. Glyphosate + 2,4-D amine, each at 1.0 lb ai/A, were applied approximately one month prior to planting in the SB system at both locations and in the WC system at Crowley. Glyphosate at 1.0 lb/A was applied in the WC system at St. Joseph. Paraquat was applied at planting in the SB system at both locations.

In the CT system, plots were plowed with a field cultivator two to three times prior to planting. Within each of these systems, four levels of in-season herbicide input included (1) no herbicides, (2) propanil early postemergence (POST), (3) the commercial mixture of propanil plus molinate early POST (dry and water-seeded) followed by propanil (dry-seeded) or molinate (water-seeded) applied late POST, and (4) thiobencarb preplant (water-seeded) or thiobencarb plus quinclorac delayed preemergence (dry-seeded), each of which were followed by propanil plus bentazon POST. These four herbicide programs will be referred to as no in-season herbicides and low, moderate, and high input herbicide programs, respectively. Propanil, propanil + molinate, bentazon, thiobencarb, quinclorac, and molinate were applied at 4.0, 4.5, 1.0, 3.0, 0.5, and 3.0 lb ai/A, respectively.

Seeding rates for 'Cypress' rice were 100 and 150 lb/A in the dry- and water-seeded systems, respectively. At Crowley in both seeding methods, 90 pounds actual nitrogen (N/A) were applied preflood followed by 65 lb N/A at midseason. At St. Joseph, 135 lb N/A were applied preflood in the dry-seeded system. In the water-seeded system, and 90 lb N/A were applied preplant followed by 65 lb N/A at midseason. An additional 35 lb N/A were applied following the mid-season application in the WC system for both seeding methods. Rice foliage in this system was showing visual indications of N stress.

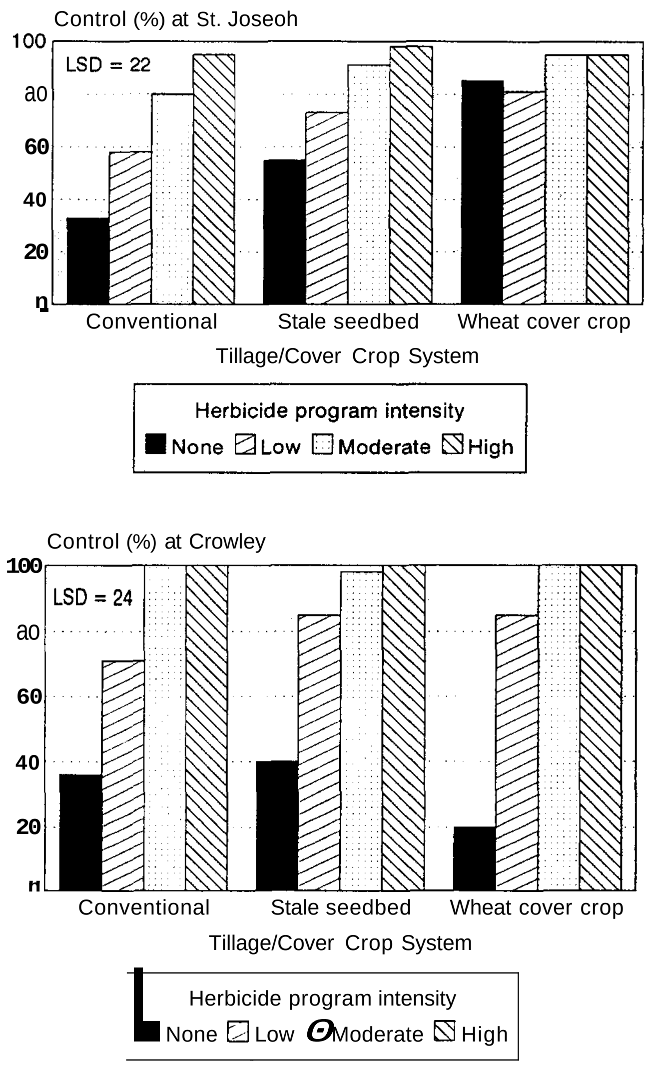

Figure 1. Barnyardgrass control with herbicide programs and tillage/cover crop systems in dry-seeded rice production.

Visual estimates of percent weed control were recorded at planting, at permanent flood establishment (dry seeded) or when rice was drained for the first N application (water seeded), at mid season, and at harvest. A scale from 0 to 100% was used in making the visual estimates where O=no control and l00=complete control. Plots were machine-harvested when rice grain moisture was between 16 and 20%. Data were subjected to analysis of variance and means for individual locations were separated with Fisher's Protected LSD test at $P < 0.05$.

Results and Discussion

Dry-seeded Production

Greater season-long barnyardgrass control was noted in the WC system compared to the SB and CT systems at St. Joseph when in-season herbicides were not applied (Figure 1). Less control was observed in the CT system compared to the SB system. In contrast, barnyardgrass control in the WC system at Crowley was lower than in the CT and SB systems. At St. Joseph in the CT system, barnyardgrass control with the low, moderate, and high input herbicide programs was 57, 80, and 95%, respectively. In the SB and WC systems, control with the low, moderate, and high input herbicide programs was 73, 91, and 98%, respectively, and 80, 95, and 95%, respectively. At Crowley, the low input herbicide program in the CT, SB, and WC systems provided 71, 84, and 84% control, respectively. At both locations, control with the moderate and high input systems was similar regardless of the tillage/cover crop system.

At St. Joseph, rice yields were greater when in-season herbicides were applied in the CT and SB systems (Figure 2). A trend for increased yield was noted as the intensity of the herbicide program increased. When in-season herbicides were not applied, yields with the SB and WC systems exceeded that with the CT system. No differences were noted among the herbicide programs in the WC system. At Crowley, yields in all tillage/cover crop systems generally increased when in-season herbicides were applied. Few differences in yield were noted when the intensity of the herbicide program was increased.

Water-seeded Production

At St. Joseph, purple ammania control in the CT, SB, and WC systems was 50, 2, and 65%, respectively, without in-season herbicides (Figure 3). When in-season herbicides were applied, control increased regardless of the tillage/cover crop system. At Crowley, control in the SB and WC systems exceeded that with the CT system when herbicides were not applied. The high intensity herbicide program, which contained thiobencarb, was needed to obtain maximum control. Thiobencarb is used routinely in water-seeded rice to control aquatic weeds such as purple ammania and duck salad *(Heteranthera limosa)*.

Few differences were noted among yields at St. Joseph regardless of the tillagekover crop system (Figure 4). At Crowley, the high intensity program resulted in greater yields than the other herbicide programs in the CT system. In contrast, yields were similar in the SB and WC systems regardless of the herbicide program.

Results from these studies indicate that tillage and cover crops can influence weed population dynamics and, to some degree, the intensity of herbicide programs needed to control weeds. In the dry-seeded system, barnyardgrass populations at St. Joseph were higher in the CT system compared with the SB and WC systems. Lack of soil disturbance in the SB and WC systems may have reduced barnyardgrass emergence by preventing additional seeds from being brought to the soil surface. Additionally, the WC system may also have reduced populations through the release of allelochemicals or shade. However, determining the mechanism of barnyardgrass suppression was beyond the scope of these experiments. At Crowley, fewer differences in barnyardgrass control were noted among the tillagekover crop systems.

Reasons for the differences observed between the two locations are not clear. Higher wheat populations at St. Joseph may have contributed to greater barnyardgrass suppression compared with that at Crowley, where wheat populations were lower. Soil properties (silty clay soil versus silt loam soil) also may have contributed to the observed differences between locations. Additionally, earlier rice planting at Crowley compared with St. Joseph may have contributed to differences in weed pressure and subsequent response to herbicides and tillagekover crop systems.

Differences in purple ammania infestations between the two locations also were noted. At St. Joseph, the CT and WC

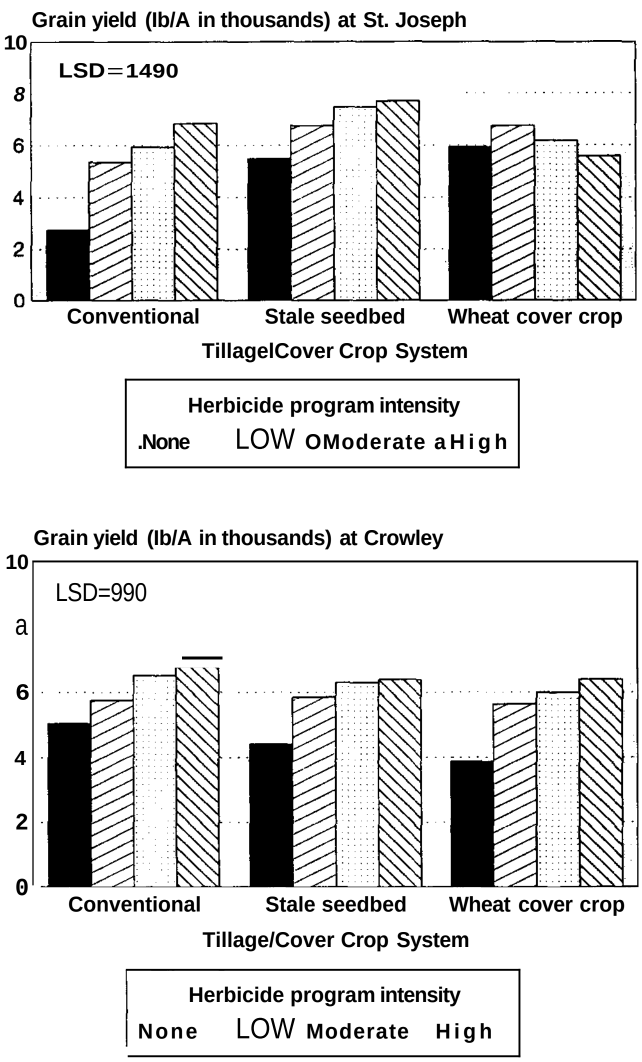

Figure 2. Rice grain yield with herbicide programs and tillage/cover crop systems in dry-seeded rice production.

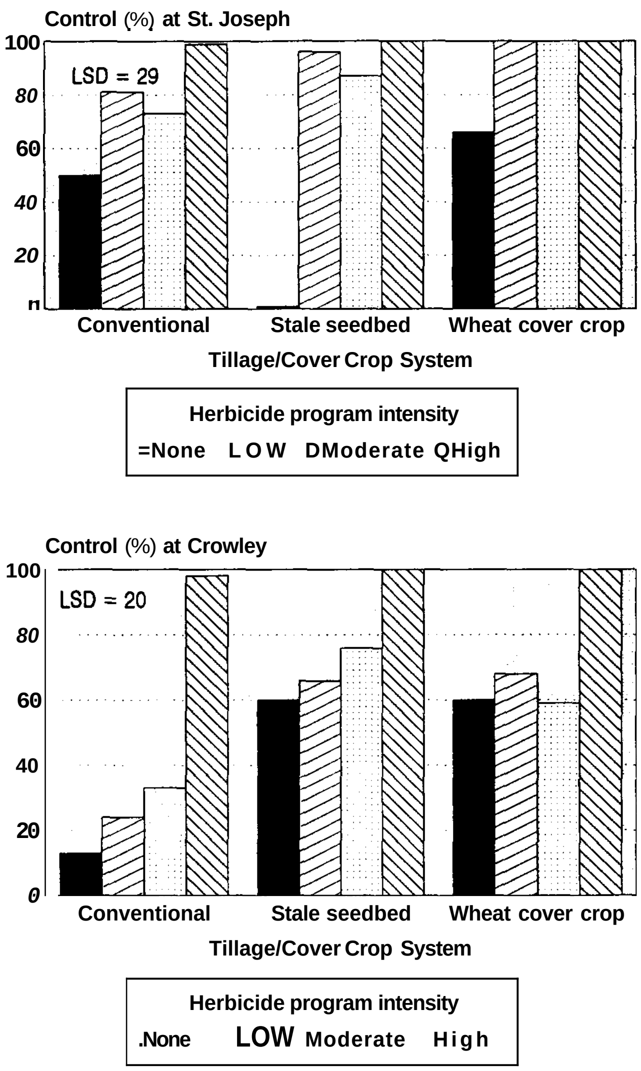

Figure 3. Purple ammania control with herbicide programs and tillagekover crop systems in water-seeded rice production.

systems provided similar control, and control with these systems exceeded that with the SB system. Differences in control may have been related to suppression of purple ammania by the WC system or tillage in the CT system compared with the SB system. Lack of tillage or cover crop suppression may have contributed to the lack of control in the SB system.

Differences in yield did not always reflect differences in weed control, and this was especially true in the water-seeded system. Increasing the intensity of the herbicide program generally resulted in increased yield in the dry-seeded system.

At St. Joseph, rice yields in the dry- and water-seeded systems were somewhat erratic in the WC system. Rice stands were reduced in the WC system relative to the other two tillage/cover systems (data not presented). Excessive decaying residues may have contributed to the difficulty in establishing stands in this system. Other research has shown adequate rice stands can be difficult to obtain in no-till production systems where heavy plant residues are present (Bollich, 1992). Factors suppressing barnyardgrass and purple ammania may also have affected the rice seedlings in the WC system. In addition, N immobilization by the wheat residue may have restricted early-seasan growth.

Collectively, these data suggest that rice produced in reduced-tillage systems can provide yields similar to those in conventional-tillagesystems in both dry- and water-seeded production. These data also indicate that changes in tillage and the use of cover crops can influence weed population dynamics and herbicide programs needed for control. Additional research is needed to further determine the advantages and disadvantages of tillage and cultural practices as related to weed management strategies with emphasis on weed control, yields, and economic returns.

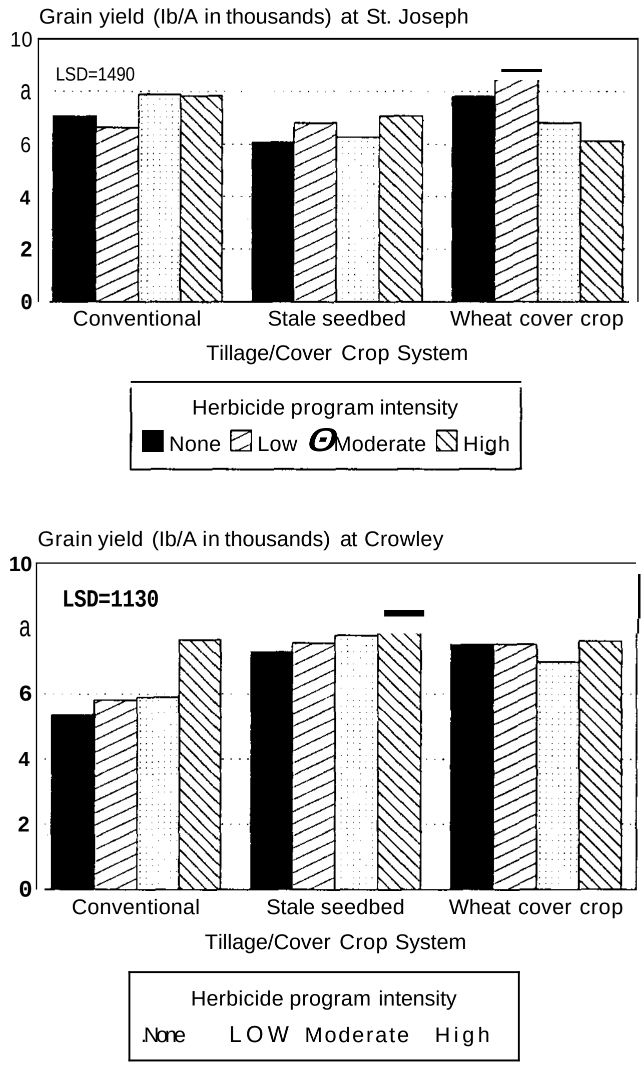

Figure 4. Rice grain yield with herbicide programs and tillage/cover crop systems in water-seeded rice production.

Acknowledgments

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