Reduced- and No-Tillage Systems for Rice

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INTRODUCTION

Conventional tillage is a soil management system that depends on tillage to control all weeds and volunteer crop plants before seeding (Stobbe, 1990). Conservation tillage is a soil management system that leaves the soil surface resistant to erosion and conserves soil moisture. Conservation tillage methods include 1) zero or no-tillage, 2) minimum or reduced-tillage and 3) mulch tillage. No-tillage and reduced-tillage systems also may have less adverse impact on the environment, especially in areas where trace amounts of chemical pesticides have been detected in groundwater and surface water (Felsot et al., 1988; Stobbe, 1990).

In Arkansas, mechanical operations used prior to planting rice vary considerably both in timing and in number from farm to farm, and this variability is quite large even among farmers from the same county who are farming the same type of soil. For example, in eastern Arkansas, the number of mechanical operations prior to planting rice can vary from a minimum of four to a maximum of eight, and the cost per hectare of these operations varies from $64 to $148.

There is a need to investigate whether the number of mechanical operations usually performed prior to planting rice can be reduced and what impact this reduction will have on weed control, grain yields and, ultimately, on net profit. Research conducted in the Philippines and in Japan in rice has demonstrated that considerable savings in time, labor, capital and energy can be achieved in land preparation without loss in yield (Brown and Quantrill, 1973; Mabbayad and Buencosa, 1967). The objective of this research was to investigate the feasibility and profitability of implementing conservation tillage practices in rice in Arkansas.

MATERIALS AND METHODS

During the first year, soybeans were grown conventionally in rows spaced 81 cm. In the second year, rice was drill-seeded in 20-cm rows. Two separate experiments were conducted with initiation of the first experiment in 1988 and the second experiment in 1989. Hence, rice was grown in the first and second experiments in 1989 and 1990, respectively.

Both experiments were located on Crowley silt loam (Typic Albaqualfs) with pH 5.8 and 0.9% organic matter at the Rice Research and Extension Center, Stuttgart, Arkansas. In both experiments, 'Newbonnet' rice was drill-seeded in late April or early May with crop emergence in May each year. Plots 30 by 8 m were arranged in randomized complete blocks with four replications.

Nitrogen fertilizer at 152 kg/ha was applied in a 3-way split with 84 kg/ha applied before flooding, 34 kg/ha applied when internodes were 1.3 cm and 34 kg/ha applied 14 days later. Water management was conventional with flooding at early tillering and draining for straighthead control. Benomyl [methyl l-(butylcarbamoyl)-2-benzimidazolecarbamate] at 0.56 kg/ha was applied twice at midseason for control of rice diseases.

Tillage treatments were as follows:

1. Conventional tillage, which included the following operations: one fall disking, one spring disking, one field cultivating, land planing twice and field cultivating again just before drill-seeding rice.
2. Reduced-tillage, which included spring disking once, land planing once and then field cultivating once just before drill-seeding rice.
3. Reduced-tillage, which consisted only of field cultivating three times just before drill-seeding rice.
4. Reduced-tillage, which consisted of field cultivating once and land planing once just before drill-seeding rice.
5. No-tillage with glyphosate [N-(phosphonomethy1)glycinel at 0.42 kg/ha applied 14 days before drill-seeding rice. A nonionic surfactant at 0.5% v/v was added to the herbicide mixture.
6. No-tillage with glyphosate at 0.42 kg/ha + V-53482 (2-[7-fluoro-4-(2-propynyl)-2H-1,4-benzoxazine-3-one-6-yl]-4,5,6,7-tetrahydro-2H-isoindole-1,3-dione) at 0.086 kg/ha applied 14 days before drill-seeding rice. A crop oil concentrate at 1% v/v was added to the herbicide mixture.

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Tillage was performed with standard commercial equipment including disk-harrows, land levellers and field cultivators. Rice was seeded in 1989 with a commercial heavy-duty grain drill and in 1990 with a commercial no-till grain drill. In the two no-till systems, burndown herbicide treatments were applied with a tractor plot sprayer in 190 L/ha spray mixture pressurized with CO_2.

In all treatments, weeds were controlled in rice with propanil [N-(3,4-dichlorophenyl)propanamide] at 3.4 or 4.5 kg/ha applied sequentially early postemergence or with propanil and thiobencarb [S-[(4-chlorophenyl)methyl] diethylcarbamothioatel each at 3.4 kg/ha applied in a tank mixture. Herbicides were applied to rice with a CO_2-pressurized backpack sprayer in 190 L/ha of spray mixture.

Data collected included weed control and crop injury ratings (0 = no control or crop injury; 100 = all weeds or crop plants killed), rough rice grain yield (kg/ha), total mill and head rice and bran yield (%), seed weight (g/1000 grains), days from emergence to 50% heading and seed germination (%). A partial economic analysis was conducted to obtain net returns from each plot using standard costs of production inputs and the market value for rice grain. Average values of $0.30, $0.20 and $O.O6/kg were used for head rice, broken kernels and bran, respectively. Also, an average deficiency payment of $0.10/kg was an added value. All data were analyzed by analysis of variance with significant means separated by Duncans multiple range test ($P \leq 0.05$).

RESULTS AND DISCUSSION

Glyphosate applied alone or tank mixed with V-53482 burned down winter vegetation to provide a soil environment suitable for rice germination and stand establishment comparable to that in conventional tillage. The winter weed complex included annual bluegrass *(Poa annua* L.), horseweed *[Conyza canadensis* (L) Crong.], corn buttercup *(Ranunculus arvensis* L.), little barley *(Hordeurn pusillum* Nutt.) and dwarf dandelion *[Krigia cespitosa (Raf.)* KL. Chambers]. Glyphosate + V-53482 provided quicker and more complete burndown of winter vegetation than did glyphosate alone. For example, in 1990 glyphosate with surfactant burned down 75% of the vegetation by 14 days after application (when seeding rice) while glyphosate + V-53482 with crop oil burned down 95% of the vegetation during the same period.

Conventional herbicide treatments of propanil applied sequentially or tank-mixed with thiobencarb controlled barnyardgrass *[Echinochloa crusgalli* (L.) Beauv.], broadleaf signalgrass *(Brachiaria platyphylla* (Griseb.) Nash] and large crabgrass *[Digitaria sanguinalis* (L.) Scop.]. In both years, ducksalad *[Hetemnthera limosa* (Sw.) Willd.] infestations were moderate to high in conventional tillage plots while they were low in no-till plots. Ducksalad infestations in reduced-tillage systems were intermediate compared to those in conventional and no-tillage systems.

Excellent rice stands occurred both years in all tillage treatments. Grain yields were not significantly different for the various tillage systems and ranged from 6500 to 7200.

Net returns were significantly higher from reduced- and no-tillage systems than from conventionally tilled rice. Compared to conventional tillage, reduced- and no-tillage systems increased net returns from $168 to $245/ha. Reduced- and no-tillage systems decreased preplant costs for land preparation and herbicides, ranging from $20 to $50/ha compared with conventional tillage.

Tillage systems did not influence maturity of rice, total milled or head rice yields, 1000-grain weight or seed germination.

CONCLUSION

In summary, rice grown in reduced- and no-tillage systems produced grain yields comparable to rice grown in a conventional tillage system. However, costs of producing rice in reduced- and no-tillage systems were lower than costs of producing it in a conventional tillage system. Therefore, rice grown in reduced- or no-tillage systems produced higher net returns than that grown by conventional tillage. Standard herbicides controlled weeds in rice grown in reduced- and no-tillage systems as well as that grown in a conventional tillage system. Ducksalad infestations were frequently lower in reduced- and no-tillage systems than in conventional tillage. Also, glyphosate alone or tank mixed with V-53482 applied preplant burned down winter weeds in no-till rice sufficiently to permit excellent stand establishment.

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LITERATURE CITED

1. Brown, J.A. and R.A. Quantrill 1973. The role of minimal tillage in rice, with particular reference to Japan. Outlook on Agriculture 7:178-183.
2. Felsot, A.S., LF. Welsh, W.S. Curran, E.L. Knake and W.G. Ruesink. 1988. Effects of agrochemicals in conservation tillage on the environment. Illinois Research 30(3-4):11-15.
3. Mabbayad, B.B., and I.A. Buencosa 1967. Tests on "minimal tillage" in transplanted rice Philippine *Agr.* 51:541-551.
4. Stobbe, E.H. 1990. Economic management of weeds under conservation tillage. pp. 5-15. *In* Weed problems and their economic management. Symposium in the 12th Conf. Asian-Pacific Weed Sci. Soc. Seoul, Republic of Korea, August 21-26, 1989. p. 174.