Weed control in drill sown rice of southern USA

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Introduction

For many years, weed control programs for rice (*Oryza sativa* L.) in the southern United States centered on propanil for control of annual grass and broadleaf weeds (Smith 1965). Propanil was commercialized in the early 1960s and became the primary herbicide for control of barnyardgrass. By the early 1990s, 98% of the rice acreage in Arkansas was treated with at least one application of propanil each year (Carey et al. 1995). With the development of imidazolinone-resistant (IR) rice, researchers have reported increased weed control spectrum with the use of propanil based products mixed with imazethapyr (Fish et al. 2015).

Red rice (*O. sativa* L.) has been recognized as a weed in U.S. rice fields for over 150 years, and it has become increasingly troublesome in cultivated rice fields throughout the southern United States. Barnyardgrass (*Echinochloa crus-galli* L.) is another troublesome weed, and can reduce rice yields by 80% (Smith 1965). In southern U.S. rice production, weed management decisions prior to the release of IR rice were often based on the control of barnyardgrass because of the lack of herbicides available for red rice control. However, weed management in Louisiana changed with the development of IR rice (Fish et al. 2015; 2016).

IR rice was discovered in 1993 through seed mutagenesis, allowing IR rice lines to be considered non-transgenic. For the first time, red rice could be economically controlled while producing a crop of rice with the use of imidazolinone herbicides (Fish et al. 2015; 2016). Herbicide mixtures have proven to be beneficial in improving efficacy and broadening the weed control spectrum in IR rice. Research has shown that the addition of propanil, or one of many other herbicides labeled in rice, to imazamox or imazethapyr can increase alligatorweed [*Alternanthera philoxeroides* (Mart) Griseb], barnyardgrass, hemp sesbania [*Sesbania herbacea* (Mill.) McVaugh], red rice, and Texasweed [*Caperonia palustris* (L.) St. Hil.] control in IR rice production. The use of different modes of action in a single spray mixture can be part of a herbicide resistance management strategy.

IR rice inbred lines became commercially available in 2002, and hybrid IR rice became available 2 years later. The IR technology is primarily used to control red rice during the growing season, and this also allowed producers to grow rice year after year with no rotation. However, continuous rice was not a part of the stewardship program developed by BASF. There are issues with out-crossing of IR lines and/or hybrids with red rice that can escape future control measures. The hybrid rice also has dormant seed characteristics which can become a weed problem as an F_2 the following year. These out-crosses and the F_2 rice plants coupled with red rice form a complex that is referred to as weedy rice. A non-GMO herbicide resistant rice is currently under development by BASF, and this new technology is known as Provisia© rice. The target herbicide for use with Provisia rice is quizalofop.

Weed management decisions often drive the overall rice production system, and numerous herbicides are available for use in rice (Webster et al. 2014). IR rice provided a major advancement in weed management technology for producers. This presentation will focus on weed management practices in southern rice production, and explore advances in herbicide development and new herbicide resistant rice.

Material and Methods

Research, for each trial discussed, was conducted at the LSU H. Rouse Caffey Rice Research Station near Crowley, Louisiana on a Crowley silt loam soil with pH 6.4 and 1.4% organic matter. The experimental design, unless otherwise stated, was a RCB with 4 replications. An experimental 'Provisia' line was planted in research evaluating quizalofop and 'CL 111' was planted in all other research studies.

Results and Discussion

A study evaluated the control of red rice and hybrid Clearfield 'CLXL 745' rice and the tolerance of a Provisia inbred line to quizalofop. The initial application of quizalofop was applied at 80 and 100 g ai/ha on rice in the two- to three-leaf stage or 100 g/ha on one- to two-tiller rice. A sequential application of quizalofop at 124, 145 or 166 g/ha was applied to rice in the one- to two-tiller stage or panicle initiation growth stage. Control of red rice and CLXL 745 was 94 to 98% when treated with quizalofop. In another study, quizalofop was mixed with several herbicides with broadleaf and sedge activity to determine mixture interactions. Quizalofop was antagonized when mixed with propanil at 3.36 kg ai/ha plus thiobencarb at 3.36 kg ai/ha, penoxulam at 40 g ai/ha, and several other herbicides. Slight rice crop injury was observed when experimental Provisia lines were evaluated for tolerance to quizalofop. Injury symptoms were slight yellowing of rice plants 7 days after treatment (DAT), and little to no injury at 21 DAT.

Two studies were established to evaluate the potential synergism between propanil plus imazethapyr or imazamox. The experimental design was a randomized complete block with four replications in a two-factor factorial arrangement of treatments. In the first study, factor A consisted of imazethapyr applied at 0 and 70 g ai/ha. Factor B consisted of propanil applied at 0, 1120, 2240, 3360, and 4480 kg ai/ha. In the second study imazamox applied at 0 and 44 g ai/ha was substituted for imazethapyr for factor A. The mixture combinations were applied to two- to three-leaf rice. Blouin's modified Colby's procedure was used to determine if an antagonism, synergism, or neutral interaction occurred (Blouin et al. 2010). At 21 DAT, imazethapyr plus propanil applied at 4480 g/ha increased red rice control from 82% to 93% resulting in a synergistic response, while all other mixtures resulted in a neutral response. Red rice treated with imazamox alone was controlled 81%, control increased to 90% when imazamox was mixed with propanil at 3360 or 4480 g/ha, resulting in a synergistic response. Barnyardgrass treated with all herbicide combinations resulted in a neutral response.

Benzobicyclon, currently under development by Gowan, has been available for use in Japan since 2001. This herbicide has soil activity but must be activated with establishment of a permanent flood within a few hours of application; however, this herbicide seems to be more consistent if a flood is present prior to application. Benzobicyclon has excellent activity on ducksalad [*Heteranthera limosa* (Sw.) Willd.] and other aquatic weed species, and also has activity on annual sedges, grasses, and broadleaf weeds. Benzobicyclon has an excellent fit in Louisiana rice production because producer's employee water-seeded rice production and/or permanent floods are established early on three- to four-leaf rice stage in drill-seeded rice.

Florpyrauxifen-benzyl, Loyant©, is a new postemergence herbicide under development by Dow AgroSciences, for control of broadleaf, grass and sedge weeds. This herbicide has auxin activity and is active on several grass, broadleaf, hemp sesbania, aquatic, and sedge weeds. Florpyrauxifen can be part of resistance management strategy in southern rice production.

Conclusions

Weed control continues to evolve in U.S. rice production, and this includes the development of new herbicides, new herbicide resistant rice, and new invasive weed species. On average, over the past 19 years, at least one new herbicide has been labeled in rice per year in the U.S.

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