Chapter 7

Rice Weed Control

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Weeds compete with rice for sunlight, nutrients and water and, when not controlled, reduce yield. In addition to competitive yield loss, weed seeds can reduce rice quality and grade. Economic losses from quality and grade reductions are usually quantified at the mill, but competitive losses may go unnoticed when scattered weeds are left uncontrolled for the duration of the production season. Secondary effects of weeds are numerous and include reduced harvesting and processing efficiency, increased insect and disease severity and increased production costs, as well as increased soil seedbank which produces even more weeds in future crops and contributes to the development of herbicide-resistant weeds. Weed control costs in Rice Research Verification Program (RRVP) fields between 2006 and 2012 averaged $68.91 per acre. During this same time period, the number of herbicide applications, including burndown, in the RRVP has ranged from 1.6 to 2.2 per acre per year, with an overall average of 2.0 per acre per year. Custom application of herbicides typically represents nearly 15 to 20 percent of the costs associated with weed control. Arkansas rice growers spend an estimated $100 million each year on weed control alone.

Effective management of weeds requires an understanding of how and when they compete with rice. Weeds vary in their competitive effects with rice (Table 7-1). In weed competition studies, rice grain yield reductions have ranged from 82 percent with red rice to 10 percent with eclipta. Factors that influence yield loss from weed competition include weed species, duration of competition, weed density, rice cultivar characteristics and other cultural management dynamics that influence rice growth. The influence of rice cultivar in fields with a history of high weed density, especially red rice, is often overlooked. Semi-dwarf or short rice cultivars generally have greater yield losses from weed competition compared to taller rice cultivars. The ability of a cultivar to tiller and its canopy architecture (erect or horizontal leaves) may also influence its ability to compete with weeds. For example, Lemont (semi-dwarf) yields were reduced by 17 percent by red rice densities of 8,100 red rice plants per acre. In comparison, Newbonnet (short-statured) yields were decreased by only 7 percent by the same red rice population. In more recent studies, more aggressively tillering, taller rice cultivars such as XL8 competed better with red rice than conventional rice cultivars (Table 7-2).

Table 7-1. Rice yield loss from heavy, season-long weed interference.

Weed Species	Potential Yield Loss	Critical Time to Control to Avoid Yield Loss
	%	
Red rice	82	mid-season
Barnyardgrass	70	early season
Bearded sprangletop	36	early season
Amazon sprangletop	35	early season
Broadleaf signalgrass	32	early season
Annual sedge	50	early season
Ducksalad	21	mid-season
Hemp sesbania	19	mid-season
Spreading dayflower	18	mid-season
Northern jointvetch	17	mid-season
Eclipta	10	mid-season

Source: R.J. Smith, Jr. 1988. *Weed Technology*. 2:232-241.

Table 7-2. Red rice density (plants/m^2) at 12 weeks after emergence†.

Variety/Hybrid	Red Rice Seeding Rate			
	2.4	3.6	6.0	12.0
	plants/m^2			
CL161	1.12	1.35	2.78	4.44
Cocodrie	1.22	1.54	2.41	4.06
Lagrue	0.87	1.44	2.41	3.71
Lemont	1.44	2.14	2.92	4.67
XL8	1.00	1.47	2.12	3.41
LSD $_{(0.05)}$	0.46			

† 1 m^2 is approximately 1 yd^2.

Source: Ottis, B.V., K.L. Smith, R.C. Scott and R.E. Talbert. 2005. *Weed Sci.* 53:499-504.

Research on the duration of weed competition has provided information on when each weed species competes with rice. Table 7-1 lists the critical time that several weeds should be controlled to avoid yield losses. Most grass weeds, except red rice, are highly competitive with rice early in the growing season and should be controlled shortly after emergence. For example, barnyardgrass grows faster and develops more biomass than rice during the early season, which gives it a competitive advantage. Red rice and most broadleaf weeds compete with rice later in the season and thus can be controlled later in the season without significant yield losses.

Weed thresholds have been established from weed density and duration studies to serve as a guide for determining the need for an herbicide application. In rice fields, there are generally multiple weed species that can potentially reduce rice yield and quality. Correct seedling weed identification in the field is critical for proper herbicide selection.

Herbicide Resistance Management

Resistance to several rice herbicides, including Facet, Londax, Newpath, Grasp, Regiment, Command, Permit and propanil, has been documented. In addition, barnyardgrass with multiple resistance to Newpath, Facet and propanil has now been identified. Options for control of this barnyardgrass include Bolero, Prowl, Command, Ricestar and Clincher. Research has shown that the risk of barnyardgrass developing resistance to ALS herbicides increases substantially in the absence of Command. Field research also shows that there are fewer barnyardgrass escapes at harvest in Clearfield rice if the season starts with an application of Command, Command and Facet, or Prowl and Bolero. Rice flatsedge, smallflower umbrella sedge, and yellow nutsedge have developed resistance to the ALS herbicides (Permit, Newpath, Regiment, Grasp, etc.). Over the past few years, the occurrence of ALS-resistant sedges, primarily rice or annual flatsedge, has been on the increase.

Following the introduction of Clearfield rice, outcrossing of the imadazolinone-resistant gene into red rice has also been documented. This outcrossing between Clearfield rice and red rice creates red rice offspring that are resistant to Newpath herbicide. Red rice resistant to Newpath and other herbicides with the same mode of action seriously jeopardizes the Clearfield technology. Widespread distribution of resistant red rice would nullify the benefits of Clearfield and destroy the only effective means of controlling this serious weed pest. Prevention of weed resistance to herbicides can be managed by strict adherence to rotation of herbicide chemistry (mode of action) and crops grown in the rotation. See the herbicide resistance section of MP44 (*Recommended Chemicals for Weed and Brush Control in Arkansas*) for additional information.

Clearfield Rice

Clearfield rice was introduced into the market in 2002. This nontransgenic rice was developed to be tolerant to the imadazolinone family of herbicides. Newpath and Beyond herbicides were developed for use in Clearfield rice. Clearpath is a premix of Newpath and Facet herbicides. While Newpath controls many grass and broadleaf weeds in rice, the primary use of the Clearfield system is for red rice and barnyardgrass control. Newpath herbicide is only labeled for use on Clearfield rice cultivars, usually designated with “CL” in the cultivar name, such as CL111, CL151, CLXL729 and CLXL745. With the exception of the hybrids, Clearfield rice cultivars may yield less than modern conventional cultivars. This may limit the “fit” for this system to red rice acres or acres with other specific weed control issues until higher yielding cultivars are released. In many cases, these weed control issues may result in CL cultivars actually yielding the most, due to lack of weed control in conventional rice.

Newpath herbicide provides both residual and contact control of weeds. Newpath should be applied twice at

4 ounces per acre for effective red rice control and control of other grass weeds. Sequential Newpath systems can be applied either 4 ounces per acre preplant incorporated or preemergence, followed by 4 ounces per acre early post or in two 4-ounce per acre post applications. In sequential post applications, the first application of Newpath should be applied to 1- to 2-leaf red rice or other grass weeds. It is beneficial and recommended that a good preemergence herbicide, such as Command, be applied after planting to control other grass weeds and help prevent resistance. The label allows up to 12 ounces per acre applied in two 6-ounce per acre applications for extremely heavy red rice infestation but is not allowed on the hybrids due to injury potential (See MP44 for specific weed and timing options.)

Newpath herbicide is not effective for jointvetch, hemp sesbania or eclipta control. Newpath should be applied in a tank-mix with a herbicide that will effectively control these weeds.

Newpath is a long-residual herbicide and persists in the soil from one year to the next. Crop safety concerns dictate that conventional rice not be planted the year following Newpath applications. Red rice resistant management requires that Clearfield rice not be planted in consecutive years. For these reasons, soybeans are usually grown in rotation with Clearfield rice. In this rotation, glyphosate or a graminicide such as Select, Assure II or Poast Plus should be used for red rice control. This rotational system will help prevent herbicide resistance from developing.

Grass Weed Control

Barnyardgrass is the most common grass weed in rice. Barnyardgrass and other grass weeds (sprangletop and broadleaf signalgrass) must be controlled soon after emergence to prevent yield loss. Once a permanent flood is established, these grassy weeds usually will not emerge.

Herbicides to control grass weeds include Bolero, Clincher, Command, Facet, Regiment, Grasp, propanil, Prowl and Ricestar HT. Herbicide selection for grass weed control should be specific for each situation. The weed response rating table (Table 7-3, next page) indicates the spectrum of activity for these herbicides applied alone or in tank-mixed combinations. The following is a brief review of several herbicides that can be used for grass control in dry-seeded rice. ***The statements included in this chapter do not imply endorsement of any product and do not substitute for labeled herbicide restrictions. Herbicide use information on labels often changes, and labels should always be checked prior to use.***

Propanil (Superwham, RiceShot, etc.)

Propanil has been the primary herbicide used for rice weed control for over 40 years. Propanil is a contact herbicide and, when used alone, generally requires a second application before the permanent flood is established for complete grass control. Good spray coverage with weed foliage is important for successful control. Weed foliage must not be covered with water at time of application. Propanil does not have any residual activity for weed control from application to the soil. Propanil activity is temperature-dependent; poor weed control may occur when temperatures are cool and rice injury can occur when temperatures are hot. Many different propanil formulations (i.e., dry flowable, SC and EC) are available and require different spray techniques. The addition of spray adjuvants to dry flowable and SC formulations is required by the labels. Spray adjuvants are not required for EC formulations. A maximum of 6 pounds a.i. per acre propanil (6 quarts per acre of 4 a.i./gal formulations) can be applied during a single growing season. A maximum of 6 pounds a.i. per acre can be applied in a single application. Below are several use precautions/tips for propanil use in weed control programs.

- Apply to grass in 1- to 3-leaf stage (Table 7-4).
- Best activity when daytime maximum temperatures are above 75°F.
- Weeds must be actively growing. Flush before spraying if weeds are moisture-stressed.
- Apply in 10 gallons water per acre to obtain good coverage.
- No surfactants, oils or additives are recommended unless using dry flowable or flowable formulations.
- Application when temperatures are > 95°F may burn rice, and propanil should not be applied at such high temperatures.
- Carbamate (Sevin, etc.) and organophosphate (methyl parathion, etc.) insecticides should not be applied within 14 days before or after propanil.

Table 7-3. Weed response ratings for rice herbicides.

HERBICIDES	HERBICIDE FAMILY	GRASSES								BROADLEAF WEEDS																SEDGES			
		Barnyardgrass[1]	Broadleaf Signalgrass	Crabgrass	Fall Panicum	Red Rice	Rice Cutgrass	Sprangletop (loosehead) (bearded sprangletop)	Sprangletop (tighthead) (Amazon)	Ammania (red stem)	Dayflower	Ducksalad	Eclipta	False Pimpernel	Gooseweed	Groundcherry	Hemp Sesbania (coffeebean)	Indian Jointvetch	Northern Jointvetch (curly indigo)	Palmleaf Morningglory	Pigweed, Palmer	Pitted Morningglory	Smartweed	Texasweed	Water Hyssop	Flatsedges	Spikerush	Umbrella Sedge	Yellow Nutsedge
Preemergence																													
League	2	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	9	7	7	2	0	2	-	8	-	8	-	0	8
Prowl delayed pre	3	8	6	8	7	0	0	6	6	0	0	4	0	0	0	-	0	0	0	0	6	0	0	0	0	0	0	0	0
Facet pre/delayed pre	4	9	9	9	9	0	0	0	0	3	5	3	8	3	3	8	6	7	7	7	4	7	0	0	6	5	-	0	0
Facet + Prowl delayed pre	4,3	9	9	9	9	0	0	7	7	3	5	3	8	3	3	-	7	7	7	8	6	8	0	0	6	5	-	0	0
Facet + Bolero delayed pre	4,8	9	9	9	9	0	0	8	8	6	7	7	9	7	5	-	8	8	8	8	5	8	5	-	6	8	7	4	0
Command + quinclorac	4,13	10	10	10	10	0	0	9	9	3	6	3	8	3	4	8	7	8	8	8	4	8	6	0	6	5	7	-	0
Bolero delayed pre	8	7	5	7	7	0	0	7	7	7	8	7	8	8	6	-	5	5	5	5	-	5	5	-	7	7	7	4	4
Bolero – Water seeded	8	8	7	7	-	8*	0	8	8	3	6	6	-	5	6	-	-	-	-	-	-	-	-	-	5	7	5	3	3
Command pre/delayed pre	13	9	9	9	9	0	0	9	9	0	3	3	3	-	0	-	2	3	3	4	0	3	2	0	0	0	0	0	0
Early Postemergence																													
Clincher	1	8	9	5	9	0	2	9	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ricestar HT	1	9	9	8	7	0	2	9	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grasp	2	8	0	0	0	0	6	0	0	7	8	9	8	-	-	8	8	8	8	4	0	5	7	7	8	9	8	0	6
Londax early post flood	2	0	0	0	0	0	0	0	0	9	7	9	8	9	9	0	6	6	6	5	0	5	6	0	9	8	8	0	6
Newpath fb Newpath/Beyond	2	9	9	9	9	9.5	9	8	7	8	5	7	0	0	5	9	0	0	0	5	0	7	9	5	0	9	9	0	8
Permit	2	0	0	0	0	0	5	0	0	5	8	3	5	-	4	6	9	3	6	0	0	4	4	5	-	8	-	0	9
Permit Plus	2	0	0	0	0	0	5	0	0	8	9	7	7	-	4	8	9	5	7	3	0	5	8	5	-	8	-	0	9
Regiment	2	8	0	0	0	0	7	3	2	6	9	9	7	-	0	-	8	7	7	4	0	5	10	7	6	8	-	3	5
Strada	2	0	0	0	0	0	0	0	0	8	7	6	7	-	-	4	9	8	9	3	0	4	5	6	-	9	-	0	7
Facet early post	4	8	9	7	6	0	2	0	0	3	3	3	9	3	3	8	8	8	8	8	4	8	0	0	3	5	-	0	0
Grandstand + Permit	4,2	0	0	0	0	0	0	0	0	8	8	4	5	-	-	4	8	9	9	9	4	9	7	9	-	9	-	3	9
Facet + propanil early post	4,7	9	9	7	9	0	2	4	5	6	5	6	9	7	5	8	9	9	9	8	8	8	6	6	8	9	9	3	5
Grandstand + propanil early	4,7	9	9	7	9	0	0	4	5	9	5	8	9	8	8	4	9	9	9	9	9	9	7	8	8	9	9	3	5
Basagran early	6	0	0	0	0	0	0	0	0	8	9	6	8	7	7	0	3	3	3	8	0	3	7	0	8	8	8	7	6
Basagran + propanil early	6,7	9	9	7	9	0	2	4	5	9	9	7	9	8	7	4	9	9	9	8	7	5	8	6	9	9	9	8	7
Propanil early (weeds less than 2")	7	9	9	7	9	0	1	4	5	6	5	7	8	7	5	-	9	9	9	4	7	4	6	6	8	9	9	5	4
Propanil fb propanil	7	9	9	7	9	0	2	7	8	6	6	7	9	7	5	-	9	9	9	5	9	5	8	6	8	9	9	6	6
Propanil + Londax or Duet prior to flood	7,2	9	9	7	9	0	2	4	5	9	8	7	9	8	9	0	9	9	9	9	7	9	8	5	8	9	9	6	8
Propanil + Permit	7,2	9	9	7	9	0	1	4	5	6	9	7	8	7	5	6	10	9	9	4	7	4	6	5	8	9	9	3	9
Propanil + Prowl early	7,3	9	9	7	9	0	1	9	9	7	5	7	9	7	6	-	9**	9**	9**	5	7	5	6	4	7	9	7	3	5
Propanil + Bolero early	7,8	9	9**	7	9	0	2	9	9	8	8	8	9	9	6	-	9**	9**	9**	5	0	5	6	4	9	9	9	8	5
Aim	14	0	0	0	0	0	0	0	0	6	7	5	7	-	-	8	9	6	6	10	6	10	9	3	7	0	0	3	0
Sharpen	14	0	0	0	0	0	0	0	0	8	7	5	9	-	7	8	9	9	9	9	9	10	-	8	8	8	-	6	6
Ultra Blazer + propanil early	14,7	8	8	7	8	0	1	4	5	6	5	7	8	7	5	8	9	6	9	8	9	8	7	3	8	8	8	2	5

*Water seed pin-point flood culture. **Postemergence control only.
Rating Scale – 0 = No Control 10 = 100% Control.

[1]Some biotypes of barnyardgrass in Arkansas are resistant to Command, propanil, Facet or both (Facet + propanil), and Newpath, Grasp, and Regiment.

- Prevent drift of the above-listed insecticides from adjacent wheat fields onto rice during the propanil-use season.
- Avoid contaminating mixing and spray equipment with insecticides when using propanil.
- Cotton is extremely sensitive to propanil drift, and heavy drift rates prior to cotton emergence can cause injury.
- Soybeans are sensitive to propanil drift.
- Avoid drift to gardens.

Propanil-resistant barnyardgrass has been found throughout most of Arkansas. Propanil-resistant barnyardgrass occurs most frequently in fields where rice has been grown continuously or in a 1:1 rice-soybean rotation. Resistance occurs less frequently in fields where rice is followed by two years of soybean in rotation. Herbicides that control propanil-resistant barnyardgrass include Bolero, Clincher, Command, Facet, Prowl, Ricestar HT and tank mixtures of these

Table 7-4. Weed sizes for optimum control with propanil†.

Weed	Weed Height	Number of Leaves
	inches	#
Fall panicum	1-3	1-3
Broadleaf signalgrass	1-3	1-3
Sprangletop	1-2	1-2
Morningglory	3	2-3
Ducksalad	1	2
Redstem	1	2-4
Smartweed	2	2-4
Volunteer milo	5	4-6
Northern jointvetch	12	--
Hemp sesbania	36	--
Flatsedge	1-2	3

† Use 4 lbs per acre rate if 4-leaf barnyardgrass is present or on larger stages of weeds listed above.

herbicides. Strategies for preventing and managing propanil-resistant barnyardgrass include:

- Use a one-year rice followed with a two-year alternate crop rotation where possible.
- Use residual herbicides such as Bolero, Command, Facet or Prowl with propanil.
- Use Command and/or Facet preemergence or delayed preemergence.
- Do not use the same herbicide strategy more than two consecutive times on a field that is in rice.

Clincher and Ricestar HT

Clincher and Ricestar HT are both effective for control of barnyardgrass and other grass weeds of rice. They will control both Facet and propanil-resistant barnyardgrass. As with other graminicides, tank mixtures with 2,4-D and other broadleaf herbicides may result in antagonism. Performance of these herbicides is severely reduced under dry conditions. Clincher provides good control of barnyardgrass up to 10 days postflood. At least two-thirds of target weeds should be above flood water. Excellent spray coverage is needed with both Ricestar HT and Clincher. These products do not injure soybeans.

Residual Herbicides

Herbicides that provide residual weed control from soil application are Bolero, Command, Facet, League, Newpath and Prowl. A preemergence application of Command has become the standard starting point for a rice weed control program. However, these herbicides may be tank mixed with propanil and other products for contact and residual grass control or used alone prior to weed emergence in most dry-seeded rice weed control programs. In situations where postemergence applications may be difficult, combinations of Command or Prowl plus Facet or Bolero are often used for extended residual weed control. Because of the development of resistant biotypes of barnyardgrass and difficulties with post emerge applications, it is strongly recommended that preemergence herbicides be flushed in if it does not rain.

Bolero 8E

Environmental and cultural practices affect the length of residual activity of Bolero. Bolero can be applied delayed preemergence or postemergence with propanil. Bolero may injure rice if applied before germination water is imbibed. To prevent injury and maximize Bolero activity, apply to a soil surface that has been sealed by a rain or flushing. Residual activity is decreased if the soil becomes dry and cracks. Bolero (3 to 4 pints per acre) applied as a delayed preemergence treatment provides excellent control of sprangletop, barnyardgrass and several aquatic weeds. Delayed preemergence applications should be made 1 to 5 days before rice emergence or about 5 to 9 days after planting, provided that adequate moisture is present for rice seed to have imbibed water for germination. Drain any surface water before Bolero application. A rainfall or flush is required for activation if the soil begins to crack or if grass begins to germinate. Bolero provides poor control of broadleaf signalgrass. A maximum of 4 pounds a.i. per acre (4 pints per acre) can be applied during a single growing season. Most Bolero is applied either tank mixed with Prowl or Facet as a delayed preemergence treatment or with propanil as an early postemergence treatment. Bolero has been used extensively for aquatic weed control in water-seeded rice. Refer to Table 7-3 for more detail on specific weed control ratings with Bolero.

Command 3ME

Applied preemergence, Command provides excellent control of barnyardgrass, sprangletop and broadleaf signalgrass. The Command rate will influence the length of residual. Research has shown excellent

residual grass control from 0.3 pound a.i. per acre on silt loam soils. A followup herbicide treatment is generally required before flooding to "clean up" annual sedges and broadleaf weeds. Broadleaf signalgrass will usually be the first grass to "break" following application.

Command can be applied to dry-seeded rice from 14 days before seeding to 7 days after seeding. If applied before seeding, do not incorporate. Application rates vary with soil texture. Silt and sandy loam soils require 0.28 to 0.38 pounds of active ingredient per acre (12 to 16 ounces per acre), and 0.47 to 0.56 pounds of active ingredient per acre (20 to 24 ounces per acre) is recommended for clay soils. Labeled application rates range from 16 to 24 ounces per acre. Some bleaching can be expected following Command application, especially following a flush or a soaking rain in cool temperatures. Bleaching gradually diminishes as the soil dries but may return with flushing or rainfall. Bleaching is generally not a problem, causes no yield loss or reduced seedling vigor and is greater on the sandy and silt loam soil textures.

If rice is seeded into a stale seedbed, care should be taken to insure the drill gaps close and cover the seed. (This is a good idea regardless of whether Command is used or not. Recent data suggests that open furrows with Command result in no worse injury that open furrows without Command – open furrows typically result in reduced stands compared to closed furrows). Shallow seeding, herbicide overlaps and other factors that result in poor application accuracy or slow-growing rice may increase early-season bleaching.

Levees pulled after Command application may require additional weed control. Refer to Table 7-3 for specific weed control ratings.

Quinclorac (Facet 75DF, Facet L, Quinstar)

Quinclorac is primarily a grass herbicide that also controls several important broadleaf weeds. Quinclorac can be applied preemergence, delayed preemergence or early postemergence. Quinclorac may also be applied to the soil surface prior to planting in stale or no-till seedbeds. Quinclorac enters weeds mainly through root uptake; therefore, adequate moisture is important for maximum activity. Rice must be at least in the 2-leaf stage for quinclorac use in water-seeded rice and the flood water must be drained before application.

The labeled application rates for quinclorac are dependent on soil texture. Coarse (sandy loam) soils require 0.33 pounds per acre, silt loams require 0.5 pounds per acre and clay and clay loams require 0.67 pounds per acre for preemergence and delayed preemergence weed control. Quinclorac should not be used on sandy soils with poor water-holding capacity because it may leach and reduce weed control. Delayed preemergence or early postemergence applications of quinclorac should be made to a moist soil or when frequent rains or flushing keeps the soil moist for improved weed control to be expected.

For foliar or postemergence grass control, the recommended application rates are from 0.17 to 0.67 pound per acre depending on soil texture and the length of desired residual control. Crop oil or an EC propanil formulation should be tank mixed with quinclorac for postemergence weed control. Crop oil concentrate is required for quinclorac applied alone or tank mixed with flowable or dry flowable propanil formulations. If an EC formulation of propanil is used, spray adjuvants are not needed. A maximum of 0.75 pounds per acre can be applied during a single growing season.

Rice tolerance to quinclorac has been excellent regardless of application method. However, if rice seeds are exposed to direct spray or young plants are under stress, injury may occur. Quinclorac provides excellent residual control of barnyardgrass, broadleaf signalgrass, morningglory, hemp sesbania and northern jointvetch. Quinclorac has little or no activity on sprangletop, smartweed or nutsedge. If fields have a history of these weeds, a tank mix with another herbicide or a preflood application of another herbicide may be necessary. Although common purslane and carpetweed are not controlled by quinclorac, these weeds should be controlled by the flood. If weeds emerge after application, rainfall or flushing may be required for activation and reactivation. Tomatoes and cotton are extremely sensitive to quinclorac. Follow all Arkansas State Plant Board application guidelines to reduce drift and prevent injury to nontarget plants.

League

League is a Group 2 systemic herbicide that provides both preemergence (residual) and postemergence control. League should be applied preemergence at 6.4 fl oz/A, which should provide effective control of rice flatsedge (annual sedge), yellow nutsedge, hemp sesbania (coffeebean), northern jointvetch and

Texasweed. Seed directly exposed to League may be injured; hence, soil should be sealed prior to application. Postemergence applications of League are recommended at 3.2 fl oz/A plus NIS at 0.25% v/v, which allows for sequential applications if needed. Postemergence applications will provide control of a similar spectrum as preemergence applications; however, residual control will be reduced due to the lower use rate of the postemergence application. It should be noted that ALS-resistant populations of rice flatsedge and yellow nutsedge exist, and League will provide no control of these resistant populations. League can be tank-mixed with Command when applied preemergence for control of a broad assortment of grasses, broadleaves and sedges. Postemergence tank-mix options may include Newpath in Clearfield rice or Facet or propanil in conventional rice.

Prowl H_2O

Prowl can applied (delayed preemergence) for residual grass control or be tank mixed with Facet, Bolero or propanil in early postemergence applications. Prowl should only be used on dry-seeded rice. When applied as a delayed preemerge, the soil should be sealed by a rain or flush and any surface water should be drained before application to prevent crop injury. Rice seed should have imbibed germination water before application. Prowl controls both barnyardgrass and sprangletop but is weak on broadleaf signalgrass. Refer to Table 7-3 for specific weed control ratings.

Broadleaf and Aquatic Weed Control

Broadleaf weeds reduce rice yield by direct competition and also reduce grade if they produce dark-colored seeds. The broadleaf weeds – dayflower, hemp sesbania, northern jointvetch, smartweed and morningglory species – are dark-seeded weeds common in much of Arkansas. These broadleaf weeds will not germinate once a permanent flood is established. However, they are problems if they emerge prior to flooding or if they emerge after flooding on levees or areas in the paddy that are allowed to dry. Hemp sesbania, northern jointvetch, palmleaf morningglory, dayflower and smartweed thrive in flooded soils if they are allowed to emerge prior to flooding. Other morningglory species like entireleaf or pitted morningglory do not usually survive prolonged flooding. All morningglory species can be problems on levees. Other weeds that can be found on levees include cutleaf groundcherry, sicklepod, cocklebur, velvetleaf and pigweed. Eclipta is another broadleaf weed that survives flooding, may interfere with harvest and increases moisture of harvested grain.

Most broadleaf weeds can be controlled before or after flooding without yield or quality loss. Because broadleaf weeds usually emerge after barnyardgrass, herbicides that control broadleaf weeds are usually applied shortly before or after flooding. Most broadleaf weeds common to Arkansas rice cultures are annual weeds germinating from seed; therefore, they are usually easier and more economical to control when they are small. There are numerous preflood control options that can be used alone or in combination to provide good broadleaf weed control. General use guidelines for several herbicides that are specific for broadleaf weed control are reviewed below. Refer to Table 7-3 for specific weed control ratings for each herbicide.

Aim

Aim is a contact herbicide with no residual that can be applied alone for effective control of cocklebur, jointvetch, hemp sesbania, smartweed and morningglories. It is a relatively inexpensive herbicide that performs well under good conditions and on small weeds. It can be tank mixed with Facet or propanil on larger weeds or to improve its spectrum of weeds controlled. Aim can also be applied as a harvest aid for morningglories up to 3 days prior to harvest.

Basagran, Ultra Blazer and Storm

Basagran, Ultra Blazer and Storm can be applied alone or tank mixed with propanil to increase their spectrum of control. Storm is a package mix of Basagran and Ultra Blazer labeled for rice. Storm applied at 1.5 pints per acre is equal to 1 pint of Ultra Blazer plus 1 pint of Basagran.

Basagran tank mixed with propanil will increase activity on smartweed, cocklebur, redstem, dayflower, spikerush, yellow nutsedge and flatsedge. For most effective control, Basagran should be applied when broadleaf weeds are small. Basagran does not provide residual control.

Ultra Blazer can be tank mixed with propanil and applied preflood to control small morningglories. Ultra Blazer applied alone may also be used to control

large hemp sesbania postflood. Apply Ultra Blazer when hemp sesbania is 1 to 5 feet and morningglory runners are less than 1 foot long. Propanil plus Ultra Blazer is a good levee treatment for groundcherry and is a good alternative for 2,4-D levee sprays if cotton or other sensitive crops are nearby. Ultra Blazer may cause foliar burn on rice, but symptoms will be quickly outgrown. Label restrictions prohibit applying more than 1 pint Ultra Blazer per acre per season. The addition of Ultra Blazer may reduce propanil activity on grasses. Ultra Blazer must be applied 50 days before harvest or no later than the early boot stage. When applied alone, Ultra Blazer requires the addition of a surfactant.

Grandstand-R 3SL

Grandstand is a hormone-type herbicide that can be applied preflood or postflood. It is commonly tank mixed with propanil to increase the spectrum of control. Grandstand plus propanil provides control of northern jointvetch, hemp sesbania, morningglory and several aquatic weeds.

Grandstand may be applied to dry- or water-seeded rice starting at the 2- to 3-leaf stage. The flood must be delayed for 72 hours to prevent injury from Grandstand applications made prior to flooding. For postflood application, weeds should be exposed before application. If the flood is lowered for this purpose, the crown of rice plants should not be exposed above the water level. Flood level should not be raised for 48 hours after application. To avoid rice injury and possible yield loss, Grandstand should not be applied after ½ inch internode elongation. If more than one application is made to rice during a single season, applications must be at least 20 days apart. A maximum of 2 pints per acre Grandstand 3SL can be applied per season but only 1 pint per acre for each application. A surfactant or crop oil concentrate will enhance performance if Grandstand is applied alone or with dry-flowable formulations of propanil. Coverage of weed foliage is important for optimum control. The Grandstand label prohibits tank mixes with liquid nitrogen and zinc fertilizers. Spray to drift to sensitive crops, especially cotton or blooming soybeans, should be avoided. Cotton is less sensitive to Grandstand than to 2,4-D, but drift rates may cause yield reductions. A preplant burndown application may be made at least 21 days before rice is dry seeded or 14 days before water seeded.

Londax 60DF

Londax is a herbicide that is primarily used for aquatic weed and yellow nutsedge control. Londax plus propanil applied immediately (1 to 7 days) before flooding provides control of annual sedges and yellow nutsedge. Londax is highly water soluble and will move with irrigation water. For best results, permanent flood should be maintained and kept as static as possible for 7 days after application. A tank mixture of Londax with propanil also increases control of several broadleaf weeds (i.e., smartweed, redstem and eclipta) compared to propanil alone. Some aquatic weeds (i.e., redstem and arrowhead) have developed resistance to Londax and must be controlled by other herbicides. Weed resistance is most likely to develop in fields where Londax is used continuously, such as in water-seeded fields. Failure to control aquatic weeds in water-seeded fields may suggest the beginning of weed resistance to this herbicide.

For postflood applications, Londax should be applied within 5 days after flooding when target weeds are small. For water-seeded rice, Londax should be applied as soon as possible after rice has pegged and the flood is stabilized. Londax is weak on emerged ducksalad and roundleaf mud plantain but provides excellent control before they emerge. In water-seeded rice, excessive pumping (water flow) after application may result in poor control in the upper paddies. Londax is a slow-acting herbicide and may require several days before weeds begin to die. Most consistent results are obtained on aquatics before or just at emergence.

When applied alone or tank mixed with a dry-flowable propanil formulation, 0.25 percent nonionic surfactant or 1 percent (1 gallon per 100 gallons) crop oil concentrate should be added for improved control. Londax has a 60-day preharvest interval, and a maximum of 1.67 ounces per acre can be applied during a single growing season.

Permit or Permit Plus

Permit is generally the best herbicide choice for the control of yellow nutsedge in rice. Unlike Londax, the flood does not need to be applied following application for effective yellow nutsedge control. Permit can also be applied with a burndown herbicide like Roundup before rice is planted in situations where heavy yellow nutsedge infestation occurs before seeding. Permit is labeled for application from prior to

rice emergence until after the flood is established. Labeled application rates range from 0.67 to 1.33 ounces per acre. If applied alone or tank mixed with a dry flowable propanil formulation, addition of 0.25 to 0.5 percent nonionic surfactant or 1 percent (1 gallon per 100 gallons) crop oil concentrate is recommended. Permit can be weak on certain broadleaf and aquatic weeds. However, Permit alone or tank mixed with propanil provides excellent control of hemp sesbania and dayflower. Permit tank mixed with propanil offers broader spectrum weed control. Soybeans are very sensitive to Permit, and caution should be taken to avoid drift to soybeans. Permit Plus will control weeds like smartweed, sesbania, jointvetch and other weeds more effectively than Permit.

Sharpen

Sharpen is a Group 14 contact herbicide that has slight residual activity on some small-seeded broadleaf weeds such as Palmer amaranth. When applied alone, it provides effective control of Palmer amaranth, morningglories, hemp sesbania (coffeebean), northern jointvetch, eclipta, groundcherry and ammania. Sharpen can be applied burndown through pre-emergence at 1 to 2 fl oz/A with MSO at 1% v/v. Once rice reaches the two-leaf stage, Sharpen can be applied at only 1 fl oz/A with COC at 1% v/v up to internode elongation. Leaf necrosis (burn) may occur soon after application but will not likely persist more than 10 to 14 days. Do not add MSO to Sharpen when applying to emerged rice or crop death may result. Sharpen can be tank-mixed with Facet or propanil to broaden spectrum of control or aid in control of larger weeds. Tank-mixing Sharpen with Ricestar HT or Clincher may reduce the level of grass control obtained with the graminicide. The addition of multiple tank mix partners with Sharpen may result in excessive injury.

Strada

Strada is a sulfonylurea herbicide similar to Permit in weed spectrum and activity. One difference is that Permit has better activity on yellow nutsedge. Strada provides good control of hemp sesbania, northern jointvetch and flatsedge. Strada fits into a weed control program with Command, propanil or Newpath. The use rate for Strada herbicide is 1.7 to 2.1 ounces per acre. To improve Strada WG performance, an addition of organo-siliconic or nonionic surfactant at the rate of 0.125 and 0.25 percent v/v (0.5 to 1 quart per 100 gallons of spray solution volume), respectively, is recommended. Do not apply Strada after ½ inch internode elongation. Like Newpath, Strada is a Group 2 herbicide MOA and will not control or prevent ALS-resistant sedges.

Regiment

Regiment is a unique herbicide in that it controls a limited spectrum of both grass and broadleaf weeds. These weeds include barnyardgrass, johnsongrass, smartweed, ducksalad, dayflower, flatsedge and hemp sesbania. The use rate for Regiment ranges from 0.4 to 0.63 ounces per acre. Regiment should be applied with both a silicon-based adjuvant and liquid ammonium sulfate. University of Arkansas data has shown that including the fertilizer adjuvant to Regiment will improve activity and consistency on barnyardgrass. Regiment should be applied between 4-leaf rice and joint movement. Do not apply past panicle initiation (beginning internode elongation) or unacceptable injury may occur. Regiment can cause root injury, especially if higher than labeled rates are applied. In University trials, most injury from Regiment has not affected yields.

Grasp

Grasp can be applied early postemergence until within 60 days of harvest. Use rates of Grasp range from 2 to 2.3 ounces per acre. One quart per acre of crop oil concentrate or methylated seed oil should be added to all Grasp applications. Grasp has excellent activity on ducksalad and rice flatsedge. It also controls barnyardgrass, jointvetch and hemp sesbania. If applied at higher than labeled rates, root injury and some stunting may be observed. Flooding should be delayed for 3 days following applications of Grasp. Water-seeded rice should be well rooted prior to application.

2,4-D

Many different formulations of 2,4-D are available for application to rice. The herbicide provides economical control of many broadleaf and aquatic weeds in rice. Northern jointvetch is not effectively controlled with 2,4-D. The recommended application window for 2,4-D use on rice is very narrow. Use the DD50 prediction as a guide for application, or apply when the first elongating internode begins movement. Do not apply when internode length exceeds ½ inch.

Application after ½ inch internode elongation may result in severe crop injury and yield loss. To hasten recovery of the rice plant, apply 20 to 30 pounds nitrogen per acre within 5 days after phenoxy herbicide treatment. If nitrogen is applied first, a phenoxy herbicide can be safely applied within 5 days after nitrogen application, provided the first elongating internode is no longer than ½ inch. State Plant Board regulations must be followed concerning applications near sensitive crops. These restrictions currently impose a ban on the use of 2,4-D by both air and ground after April 15. Restrictions on 2,4-D change from time to time, so please consult the Arkansas State Plant Board web site for the most current information. Currently (2016), levee applications of 2,4-D (using a maximum boom width of 10 feet) are allowed after April 15 for pigweed control.

Aquatic Weed Control

Aquatic weeds germinate and thrive in saturated or flooded soils. Ducksalad, purple ammannia (redstem), gooseweed, arrowhead, false pimpernel and roundleaf mud plantain are found in most Arkansas rice fields. These aquatic weeds compete with rice and interfere with harvest. Aquatic weeds are generally more prevalent and yield reductions are greater in thin stands of rice and in water-seeded fields. Establishing an adequate stand of rice will reduce the potential number of aquatic weeds, as well as the potential rice yield reductions from the competition of aquatic weeds. Herbicides that control aquatic weeds include Londax, Bolero and 2,4-D. Bolero is used preflood, Londax can be used early postflood and 2,4-D can only be used from panicle initiation to panicle differentiation (½ inch internode elongation).

Harvest Aids – Sodium Chlorate

Sodium chlorate is commonly used to desiccate green foliage and weeds present in rice fields to increase harvest efficiency. The general guidelines are to apply sodium chlorate at 3 to 6 pounds a.i. per acre when rice grain is near 25 percent moisture and harvest within 4 to 7 days after application. Although sodium chlorate is typically used to desiccate the vegetation, grain moisture is also reduced. Research suggests that when used properly, sodium chlorate does not reduce head rice yield (Table 7-5). However, application of sodium chlorate at 6 pounds a.i. per acre significantly reduced grain moisture by 2 to 5 percent within 4 days after application. Head rice yields may decline if grain moisture drops below 15 percent before grain is harvested. Thus, sodium chlorate should be applied to rice that is between 18 and 25 percent moisture with timely harvest following application. Use of sodium chlorate on seed production fields is sometimes needed. Research has shown that sodium chlorate does not influence germination of the resulting seed (Table 7-6).

Desiccation of rice foliage is noticeable within 36 hours after application, especially when temperatures are high. Sodium chlorate may also reduce head rice and grain yield if applied too early, before grain fill is complete. Growers should exercise caution when considering sodium chlorate application to fields with uneven maturity to avoid yield and quality losses.

Table 7-5. Influence of sodium chlorate on rice grain yield and harvest moisture during 2000†.

Sodium Chlorate Rate	Grain Yield	Harvest Moisture‡	Head Rice	Milled Rice
lbs/A	bu/a	percent		
0	173	21.1	57.5	70.3
6	174	17.8	56.1	70.0
$LSD_{(0.05)}$	NS	11.3	NS	NS

† Study conducted at the Rice Research and Extension Center. Data is the mean for Wells and Cocodrie and across application times.

‡ Grain moisture averaged 23% on the day of sodium chlorate application.

Source: Wilson et al., 2001. p. 437-445. B.R. *Wells Rice Research Studies 2000*. Ark. Agr. Exp. Sta. Res. Ser. 485.

Table 7-6. Influence of a preharvest application of sodium chlorate on germination of resulting seed†.

Sodium Chlorate Rate	Seed Germination			
	Bengal	Cocodrie	Drew	Wells
lbs/A	percent			
0	93.5	92.0	93.7	92.3
6	95.7	90.5	96.5	94.8
$LSD_{(0.05)}$	NS	NS	NS	NS

† Study conducted at the Rice Research and Extension Center during 1999.

Source: Wilson et al., 2001. p. 437-445. *B.R. Wells Rice Research Studies 2000.* Ark. Agr. Exp. Sta. Res. Ser. 485.