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Source: Weed Technology, 22(4):565-570. 2008.

Published By: Weed Science Society of America

DOI: <http://dx.doi.org/10.1614/WT-08-051.1>

URL: <http://www.bioone.org/doi/full/10.1614/WT-08-051.1>

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Weed Management—Major Crops

Early Postemergence Clomazone Tank Mixes on Coarse-Textured Soils in Rice

S. D. Willingham, N. R. Falkenberg, G. N. McCauley, and J. M. Chandler*

Clomazone was labeled for rice in 2001; however, that label excluded its use on coarse- (light) textured soils, including sand, loamy sand, and sandy loam with less than 1% organic matter due to rice injury. Field studies conducted in 2005, 2006, and 2007 evaluated weed control and tolerance of rice to early postemergence (EPOST) applications of clomazone alone and tank mixed with other herbicides on sandy loam and clay loam soils. At 42 d after treatment (DAT), broadleaf signalgrass (BRAPP) and barnyardgrass (ECHCG) control was > 86%. At 14 DAT, rice injury was greatest (13%) from clomazone applied preemergence (PRE) at 0.44 kg ai/ha on sandy soil. Annual sedge (CYPCP) control was > 78% on sandy loam soils at 14 DAT, but increased to > 90% by 42 DAT. On clay loam soils, CYPCP control at 42 DAT ranged from 60 to 76% from clomazone alone or tank mixed with cyhalofop or fenoxaprop. All other tank mixes provided > 80% control. Hemp sesbania (SEBEX) control was > 80% from all tank mixes. Clomazone alone provided < 77% control. Data suggest that clomazone can be used EPOST in combination with other herbicides without causing significant rice injury on sandy loam soils in Texas.

Nomenclature: Clomazone; broadleaf signalgrass, *Urochloa platyphylla* (Griseb.) Nash.; barnyardgrass, *Echinochloa crus-galli* L.; annual sedge, *Cyperus compressus* L.; hemp sesbania, *Sesbania herbacea* (P. Mill) McVaugh; rice, *Oryza sativa* L.

Key words: Crop injury, herbicide combinations, weed management.

Rice is grown on an estimated 1.5 million ha annually in the United States, with approximately 80,000 ha annually grown in Texas (Scherder et al. 2004). Weeds cause problems in Texas rice production by competing with rice for nutrients and sunlight. Annual grass control is critical for optimal rice yield (Bollich et al. 2000). Weed seed in rice grain can reduce rice quality, and increase insect and disease severity, while decreasing harvest and processing efficiency (Webster et al. 1999). Three of the most troublesome weeds in rice production are barnyardgrass, sprangletops (*Leptochloa* sp.), and broadleaf signalgrass, which can reduce rice yields by 70, 36, and 32%, respectively (Smith 1988; Webster 2000). Reduced weed control from herbicide resistance to commercially available herbicides has led growers to depend on clomazone as the soil-applied herbicide to provide effective long season grass control (Scherder et al. 2004). As of 2005, propanil-resistant barnyardgrass has been confirmed in Texas, Arkansas, Louisiana, and Missouri, and quinclorac resistance has been confirmed in Arkansas and Louisiana (Talbert and Burgos 2007).

Clomazone was registered for rice in 2001 and is applied in dry- and water-seeded rice production, providing effective control of barnyardgrass, sprangletop, and broadleaf signalgrass (Anonymous 2007). Clomazone is widely used because of low cost and effective annual grass control. Research evaluating clomazone efficacy over various rates and timings (preplant incorporated [PPI], preemergence [PRE], delayed preemergence [DPRE], or early postemergence [EPOST]) has proven to be highly effective against various annual grasses,

depending on crop and geographical area (Jordan and Kendig 1998; Webster et al. 1999). Clomazone can cause chlorosis (bleaching), stunting, delayed maturity, and stand reduction, depending on the soil characteristics, application rate, and environmental conditions (Bollich et al. 2000). Several studies have reported rice injury from clomazone at different application rates (Cumming et al. 2002; Jordan et al. 1998; Kirksey et al. 1996). Bollich et al. (2000) reported up to 15% rice injury from clomazone applied PRE to rice at 0.56 kg ai/ha. Chlorosis usually increases as rate increases from 0.28 kg/ha to 2.23 kg/ha. Up to 60% chlorosis was documented 7 d after treatment (DAT) when clomazone was applied PRE at 0.45 kg/ha. Zhang et al. (2005) reported that early chlorosis did not lower grain yield, and higher clomazone rates might increase rice yield from improved weed control. Until May 2006, the registration of clomazone in rice excluded coarse-textured soils (sandy loam, loamy sand, and sandy soils) in the rice-growing area west of Houston, TX with less than 1% organic matter because of the increase in rice leaf bleaching/chlorosis. Research showed that clomazone is safe to use in rice on coarse- (light) textured soils even though injury can occur (O'Barr et al. 2007).

Clomazone can be applied as an EPOST treatment alone to rice at the one to two-leaf stage to provide PRE and residual control of grass weeds (Anonymous 2007). In rice, there are often several grass and broadleaf weeds plus annual and perennial sedges emerging, which coincide with EPOST applications of herbicides for control (Jordan 1995). This allows growers to apply herbicide tank mixes to decrease application costs. Registered use rates of clomazone controlled annual grasses but proved weak on broadleaf weed and sedge control (Talbert and Burgos 2007). Tank mixing other herbicides with clomazone was required to control rice flatsedge (*Cyperus iria* L.) and hemp sesbania (Talbert and Burgos 2007). Clomazone applied with propanil provided the

DOI: 10.1614/WT-08-051.1

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most consistent increase in rice yield over a single application of propanil (Jordan and Kendig 1998). Clomazone can control propanil-resistant barnyardgrass (Mitchell and Gage 1999), which has become a problem in southern rice-growing areas (Baltazar and Smith 1994). Clomazone applied EPOST at 0.67 kg/ha injured rice less than 10% at 7 DAT and controlled barnyardgrass > 91% at 49 DAT (Webster et al. 1999). EPOST applications provided a wider window of time for critical applications at or near the establishment of the rice crop. O'Barr et al. (2007) reported limited rice injury from PRE applications of clomazone at various rates on coarse-textured soils; however, limited data are available on EPOST applications on rice injury and weed control on coarse-textured soils. Instead of a PRE application of clomazone followed by (fb) an EPOST application of an additional herbicide, applying clomazone with the additional herbicide EPOST could benefit rice production by reducing costs and saving time. The objective of this research was to evaluate clomazone applied EPOST alone and in tank mixes with commonly used rice herbicides on rice injury, weed control, and rice yield on coarse-textured soils.

Materials and Methods

Field studies were conducted in 2005, 2006, and 2007 at the Texas Agricultural Experiment Station Research and Education Centers near Beaumont, Eagle Lake, and Ganado, TX, evaluating clomazone applied to 1- to 2-leaf rice (EPOST) in tank mixes with commonly used rice herbicides. A second study was conducted in 2006 and 2007 at Beaumont and Eagle Lake to evaluate PRE and EPOST split applications of clomazone and tank mixes of clomazone with commonly used rice herbicides applied EPOST. The soil at Beaumont was a Morey silty clay loam (fine-silty, siliceous, superactive, hyperthermic Oxyaquic Argiudolls) with 19% sand, 45% silt, 35% clay, 1.3% organic matter, and pH 7.3. Soil at Eagle Lake was a Crowley fine sandy loam (fine, smectitic, hyperthermic Typic Albaqualfs) with 59% sand, 29% silt, 12% clay, 0.7% organic matter, and pH 5.3. Soil at Ganado was an Edna fine sandy loam (fine, montmorillonitic, thermic, Vertic Hapludalfs) with 55% sand, 33% silt, 12% clay, 0.8% organic matter, and pH 6.1. Field preparation consisted of fall disking followed by precision leveling and field cultivation before planting. 'CL161' rice was dry-seeded at 90 kg/ha in the EPOST clomazone study and 'Cocodrie' was dry-seeded at 90 kg/ha in the split clomazone application study with a grain drill. Plantings dates ranged from March 27 to April 13 during the three-year study. Plot size was six rows spaced 20 cm apart by 5.4 m long. Seeds were pretreated with the insecticide fipronil {5-amino-1-[2,6-dichloro-4-(trifluoromethyl)phenyl]-4-[91,*R,S*)-(trifluoromethyl)sulfonyl]-*H*-pyrazole-carbonitrile} for rice water weevil (*Lissorhophus oryzophilus*) control. Soil fertility management at each location followed local cultural practices and state recommendations. Soil moisture was maintained by flush irrigation (briefly flooded and drained) to promote rice growth and herbicide activation.

A randomized complete block design was utilized with four replications. Herbicide treatments for EPOST clomazone

tank mixes consisted of a lower rate on coarse-textured soils of clomazone PRE and EPOST alone at 0.39 and 0.44 kg ai/ha at Eagle Lake and a higher rate on heavier soils of 0.56 and 0.67 kg/ha at Beaumont. Rates were based on soil characteristics analysis. EPOST applications of clomazone at 0.39 kg/ha at Eagle Lake and 0.56 kg/ha at Beaumont were tank mixed with the emulsifiable concentration (EC) and soluble concentration (SC) formulations of propanil at 2.24 kg ai/ha, carfentrazone-ethyl at 0.02 kg ai/ha, cyhalofop-butyl at 0.28 kg ai/ha, premix of propanil plus bensulfuron-methyl at 0.07 kg ai/ha, quinclorac at 0.39 kg ai/ha, imazethapyr at 0.07 kg ai/ha, bispyribac-sodium at 0.03 kg ai/ha, fenoxa-prop at 0.07 kg ai/ha, or penoxsulam at 0.03 kg ai/ha. Split clomazone applications at Eagle Lake consisted of clomazone applied PRE at 0.22 kg/ha alone fb clomazone at 0.33 kg/ha EPOST alone or tank mixed with propanil at 2.24 kg/ha, halosulfuron at 0.05 kg ai/ha, carfentrazone at 0.02 kg/ha, or quinclorac at 0.39 kg/ha. Additional treatments included clomazone PRE fb propanil + quinclorac EPOST, or late postemergence (LPOST), and clomazone PRE and EPOST at 0.56 kg/ha. Treatments at Beaumont were the same except for the rate of clomazone at 0.28 kg/ha PRE, 0.39 kg/ha EPOST, and clomazone treatments alone PRE and EPOST at 0.67 kg/ha. A crop oil concentrate¹ at 2% v/v was included with all treatments except with bispyribac-sodium which included a silicon-based surfactant² at 0.125% v/v. All herbicide applications were made using a CO₂ pressurized backpack sprayer with four flat-fan nozzle boom calibrated to deliver 140 L/ha.

Visual evaluation of weed control and injury indicated by chlorosis and rice plant stunting were determined using a scale of 0 to 100% where 0 = no control or no rice injury and 100 = plant death compared to the nontreated plot 14 and 42 DAT. Rice grain was harvested using a small plot grain harvester³ when grain moisture was approximately 20%. Final grain yields were adjusted to 12% moisture content.

All data were subjected to the Mixed Procedure (SAS 2002). Because of the different weed spectrum between locations, data were separated between Beaumont and Eagle Lake/Ganado. At Beaumont, years and replications (nested within year) were considered random effects. At Eagle Lake/Ganado, years, locations, replications, and interactions including year, location, and replications were considered random effects. Herbicide treatments were the only fixed effects at all locations. This allowed inferences to be made about herbicide treatments over a range of environments (Carmer et al. 1989). Type III statistics were used to test fixed effects. Fisher's LSD values are reported in the tables at *P* = 0.05. Data were presented for early-season (14 DAT) and late-season (42 DAT) weed control.

Results and Discussion

Differences between treatments were significant for rice injury and weed control in the EPOST clomazone tank mix study. At 14 DAT, injury at Eagle Lake/Ganado on sandy soils was 10% or less for all treatments except for clomazone applied PRE at 0.44 kg/ha and clomazone at 0.44 kg/ha plus propanil EC applied EPOST (13 and 11%, respectively)

Table 1. Rice injury, weed control, and yield from early-postemergence clomazone tank mixes at Eagle Lake/Ganado, TX in 2005, 2006, and 2007.^a

Herbicide treatment	Rate	Timing	14 DAT ^b			42 DAT		Yield
			Injury	BRAPP	CYPCP	BRAPP	CYPCP	
	kg/ha		%					kg/ha
clomazone	0.39	PRE	10	92	80	91	92	5,620
clomazone	0.44	PRE	13	93	82	93	93	6,330
clomazone	0.39	EPOST	5	90	82	87	92	5,970
clomazone	0.44	EPOST	5	88	81	87	91	6,090
clomazone + propanil EC	0.39 + 2.24	EPOST	5	94	85	92	94	6,250
clomazone + propanil EC	0.44 + 2.24	EPOST	11	93	85	94	93	6,640
clomazone + propanil SC	0.39 + 2.24	EPOST	5	90	84	92	93	6,420
clomazone + propanil SC	0.44 + 2.24	EPOST	6	92	85	91	93	7,080
clomazone + carfentrazone-ethyl	0.39 + 0.03	EPOST	8	89	78	93	93	6,660
clomazone + cyhalofop-butyl	0.39 + 0.28	EPOST	5	93	79	94	92	7,050
clomazone + propanil + bensulfuron-methyl	0.39 + 2.24 + 0.07	EPOST	2	92	87	94	94	7,000
clomazone + quinclorac	0.39 + 0.39	EPOST	2	92	81	92	93	6,840
clomazone + imazethapyr	0.39 + 0.07	EPOST	6	92	90	94	94	7,000
clomazone + bispyribac-sodium	0.39 + 0.03	EPOST	2	91	88	92	94	7,000
clomazone + fenoxaprop	0.39 + 0.07	EPOST	5	92	80	94	93	6,990
clomazone + penoxsulam	0.39 + 0.03	EPOST	5	89	91	88	94	6,780
propanil + quinclorac + thiobencarb	2.24 + 0.39 + 2.24	EPOST	0	93	88	92	94	5,920
nontreated			N/A	N/A	N/A	N/A	N/A	4,910
LSD (0.05)			3	4	6	6	6	657

^a Least square means by herbicide treatments were reported for 14 and 42 DAT.

^b Abbreviations: DAT, days after early postemergence treatment; BRAPP, broadleaf signalgrass; CYPCP, annual sedge; PRE, preemergence; EPOST, early postemergence (1- to 2-leaf rice); LSD, least significant difference.

(Table 1). These results are similar to O'Barr et al. 2007 with minimal rice injury from PRE applications on coarse soils. Broadleaf signalgrass control was 87% or greater from all treatments at 14 and 42 DAT. Annual sedge control ranged from 80 to 82% from clomazone alone and 78 to 81% from clomazone plus carfentrazone-ethyl, cyhalofop-butyl, quinclorac, or fenoxaprop. All other treatments including clomazone plus propanil, penoxsulam, bispyribac-sodium, imazethapyr, or quinclorac plus thiobencarb controlled annual sedge at least 84%. Once flood was established, annual sedge control increased to greater than 90%. Rice yield from the nontreated control (4,910 kg/ha) was lower than all treatments (Table 1). When clomazone was applied alone, rice yields ranged from 5,620 to 6,330 kg/ha. Tank mixes of clomazone and propanil had similar rice yield to clomazone alone treatments at the same use rate, with the exception of clomazone at 0.44 kg/ha plus propanil SC. Greater rice yields was also reported by Zhang et al. 2005 from the higher rate of clomazone due to the increase weed control despite the greater rice injury. Clomazone tank mixes with all other herbicides improved rice yields relative to the clomazone alone treatments (Table 1).

At Beaumont, rice injury was 10% or less for all treatments at 14 DAT (Table 2). Barnyardgrass control was 85% or greater from all treatments. Applications of clomazone PRE and EPOST controlled barnyardgrass at 14 DAT 97 and 85%, respectively. These results are similar to Webster et al. 1999 who reported greater than 91% barnyardgrass control with less than 10% rice injury on loam soils. Tank mixing other herbicides with clomazone EPOST improved barnyardgrass control compared to clomazone applied alone. Annual sedge control ranged from 80 to 90% except from clomazone treatments alone or clomazone plus cyhalofop-butyl, fenox-

aprop, or quinclorac. Hemp sesbania control was 80 to 84% from clomazone alone. All tank mixes had equivalent hemp sesbania control (85 to 93%) with the exception of clomazone plus cyhalofop-butyl (80%) and clomazone plus fenoxaprop (83%) (Table 2).

By 42 DAT at Beaumont, injury was less than 5% and barnyardgrass control was greater than 85% (Table 2). Annual sedge control was 80% or greater for most treatments, but only 60 to 68% from clomazone alone and 62% from tank mixes of clomazone plus fenoxaprop and cyhalofop-butyl. Hemp sesbania control was 80% or greater except from clomazone alone at 66 to 77%. Clomazone provided grass control but was weak on broadleaf weed control, similar to results from Jordan (1995) and Talber and Burgos (2007). Clomazone plus fenoxaprop, cyhalofop-butyl, imazethapyr, and bispyribac-sodium provided less hemp sesbania control (80 to 86%). Clomazone plus propanil, carfentrazone-ethyl, quinclorac, penoxsulam, and propanil plus bensulfuron provided at least 90% hemp sesbania control. Rice from the nontreated control was the lowest yielding treatment (3,676 kg/ha). When clomazone was applied alone, rice yield ranged from 3,990 to 4,880 kg/ha due to harvest interference from the lack of hemp sesbania control. Clomazone plus propanil EC and clomazone plus carfentrazone-ethyl, fenoxaprop, or cyhalofop-butyl had similar rice yield to clomazone alone treatments at the same use rate with the exception of clomazone plus propanil SC. Clomazone tank mixes with all other herbicides improved rice yields relative to the clomazone alone treatments (Table 2).

There were differences among treatments for crop injury and weed control in the split application clomazone study (Table 3). At 14 DAT at Eagle Lake, injury ranged from 9 to 18% from split applications of clomazone at 0.22 fb 0.33 kg/

Table 2. Rice injury, weed control, and yield from early-postemergence clomazone tank mixes at Beaumont, TX in 2005, 2006, and 2007.^a

Herbicide treatment	Rate	Timing	14 DAT ^b				42 DAT			Yield
			Injury	ECHCG	CYPCP	SEBEX	ECHCG	CYPCP	SEBEX	
	kg/ha		%							kg/ha
clomazone	0.56	PRE	4	96	67	80	94	68	66	4,760
clomazone	0.67	PRE	4	97	63	84	94	60	75	3,990
clomazone	0.56	EPOST	6	85	67	83	86	65	75	4,390
clomazone	0.67	EPOST	8	85	67	81	90	67	77	4,880
clomazone + propanil EC	0.56 + 2.24	EPOST	5	92	90	93	92	92	91	4,990
clomazone + propanil EC	0.67 + 2.24	EPOST	10	92	89	94	93	90	90	4,930
clomazone + propanil SC	0.56 + 2.24	EPOST	7	90	90	92	90	92	91	5,480
clomazone + propanil SC	0.67 + 2.24	EPOST	9	91	85	91	92	87	90	5,430
clomazone + carfentrazone-ethyl	0.56 + 0.03	EPOST	10	93	84	91	92	80	90	4,950
clomazone + cyhalofop-butyl	0.56 + 0.28	EPOST	6	91	77	80	93	62	80	5,100
clomazone + propanil + bensulfuron-methyl	0.56 + 2.24 + 0.07	EPOST	7	89	87	88	87	92	90	5,350
clomazone + quinclorac	0.56 + 0.39	EPOST	7	88	78	92	89	83	91	5,140
clomazone + imazethapyr	0.56 + 0.07	EPOST	9	92	90	85	93	91	86	5,420
clomazone + bispyribac-sodium	0.56 + 0.03	EPOST	6	91	82	85	87	88	85	5,570
clomazone + fenoxaprop	0.56 + 0.07	EPOST	8	91	67	83	92	62	83	4,290
clomazone + penoxsulam	0.56 + 0.03	EPOST	2	88	90	88	92	92	91	5,280
propanil + quinclorac + thiobencarb	2.24 + 0.39 + 2.24	EPOST	4	92	86	93	92	94	93	5,290
nontreated			N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,670
LSD (0.05)			5	5	8	5	3	9	9	906

^a Least square means by herbicide treatments were reported for 14 and 42 DAT.^b Abbreviations: DAT, days after early postemergence treatment; ECHCG, barnyardgrass; CYPCP, annual sedge; SEBEX, hemp sesbania; PRE, preemergence; EPOST, early postemergence (1- to 2-leaf rice); LSD, least significant difference.

ha alone or tank mixed with propanil, halosulfuron, carfentrazone, or quinclorac. Clomazone at 0.56 kg/ha alone, a rate greater than the registered rate of 0.39 kg/ha for sandy soils, injured rice greater (28%) when applied PRE compared to EPOST (11%). Broadleaf signalgrass control was greater than 90% from PRE fb EPOST clomazone applications alone or tank mixed. Clomazone applied PRE at 0.22 kg/ha fb

propanil plus quinclorac late postemergence (LPOST) controlled broadleaf signalgrass 93%, greater than clomazone applied EPOST fb LPOST (83%). Clomazone PRE at 0.56 kg/ha controlled broadleaf signalgrass (93%) greater than clomazone EPOST (85%). Annual sedge control was 86% or greater from all treatments except clomazone applied PRE fb EPOST alone or with carfentrazone-ethyl and

Table 3. Rice injury, weed control, and yield from split clomazone application preemergence and early-postemergence with tank mixes at Eagle Lake, TX in 2006 and 2007.^a

Herbicide treatment	Rate	Timing	14 DAT ^b			42 DAT		Yield
			Injury	BRAPP	CYPCP	BRAPP	CYPCP	
	kg/ha		%					kg/ha
clomazone fb	0.22 fb	PRE	12	93	80	95	95	6,850
clomazone	0.33	EPOST						
clomazone fb	0.22 fb	PRE	13	94	93	95	95	6,740
clomazone + propanil	0.33 + 2.24	EPOST						
clomazone fb	0.22 fb	PRE	9	93	95	95	95	7,120
clomazone +halosulfuron	0.33 + 0.05	EPOST						
clomazone fb	0.22 fb	PRE	18	93	82	95	95	6,540
clomazone+ carfentrazone-ethyl	0.33 + 0.02	EPOST						
clomazone fb	0.22 fb	PRE	10	94	90	95	94	6,860
clomazone + quinclorac	0.33 + 0.33	EPOST						
clomazone	0.56	PRE	28	93	79	96	95	6,660
clomazone	0.56	EPOST	11	85	91	88	95	6,280
clomazone fb	0.22 fb	PRE	5	93	86	95	95	6,650
propanil + quinclorac	2.24 + 0.33	LPOST						
clomazone fb	0.22 fb	EPOST	2	83	91	93	95	6,650
propanil + quinclorac	2.24 + 0.33	LPOST						
nontreated			N/A	N/A	N/A	N/A	N/A	6,140
LSD (0.05)			6	6	10	5	0	702

^a Least square means by herbicide treatments were reported for 14 and 42 DAT.^b Abbreviations: DAT, days after early postemergence treatment; BRAPP, broadleaf signalgrass; CYPCP, annual sedge; PRE, preemergence; EPOST, early postemergence (1- to 2-leaf rice); LPOST, late-postemergence 4- to 5-leaf rice; LSD, least significant difference.

Table 4. Rice injury, weed control, and yield from split clomazone application preemergence and early-postemergence with tank mixes at Beaumont, TX in 2006, and 2007.^a

Herbicide treatment	Rate	Timing	14 DAT ^b				42 DAT			Yield
			Injury	ECHCG	CYPCP	SEBEX	ECHCG	CYPCP	SEBEX	
	kg/ha									kg/ha
clomazone fb	0.28	PRE	0	96	47	77	90	76	72	5,350
clomazone	0.39	EPOST								
clomazone fb	0.28	PRE	0	97	79	87	95	87	85	5,520
clomazone + propanil	0.39 + 2.24	EPOST								
clomazone fb	0.28	PRE	0	96	95	95	90	95	91	5,490
clomazone + halosulfuron	0.39 + 0.05	EPOST								
clomazone fb	0.28	PRE	3	97	72	91	91	83	82	5,640
clomazone+ carfentrazone-ethyl	0.39 + 0.02	EPOST								
clomazone fb	0.28	PRE	0	97	71	75	92	81	95	5,560
clomazone + quinclorac	0.39 + 0.33	EPOST								
clomazone	0.67	PRE	0	96	55	68	92	71	72	4,910
clomazone	0.67	EPOST	0	88	49	73	84	71	77	5,160
clomazone fb	0.28 fb	PRE	0	90	84	65	85	95	91	5,450
propanil + quinclorac	2.24 + 0.33	LPOST								
clomazone fb	0.28 fb	EPOST	2	95	71	68	94	95	95	5,620
propanil + quinclorac	2.24 + 0.33	LPOST								
nontreated			N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,680
LSD (0.05)			2	6	21	4	5	11	2	945

^a Least square means by herbicide treatments were reported for 14 and 42 DAT.

^b Abbreviations: DAT, days after early postemergence treatment; ECHCG, barnyardgrass; CYPCP, annual sedge; SEBEX, hemp sesbania; PRE, preemergence; EPOST, early postemergence (1- to 2-leaf rice); LPOST, late-postemergence 4- to 5-leaf rice; LSD, least significant difference.

clomazone PRE alone at 0.56 kg/ha. By 42 DAT, broadleaf signalgrass and annual sedge control was 88% or greater, and rice injury was less than 5%. Yield ranged from 6,140 and 6,280 kg/ha from nontreated and clomazone alone EPOST to 7,120 kg/ha from clomazone PRE fb clomazone plus halosulfuron EPOST at Eagle Lake (Table 3).

At Beaumont, rice injury was less than 5% at 14 DAT (Table 4). Barnyardgrass control was at least 88% from all treatments at 14 DAT. Annual sedge control was 95% from clomazone PRE fb clomazone plus halosulfuron EPOST, and all tank mixes that included propanil had equivalent levels of control. Clomazone PRE fb clomazone plus propanil EPOST provided 79% annual sedge control. All other treatments controlled annual sedge less than 72%. Hemp sesbania control was 87% or greater from clomazone PRE fb clomazone EPOST plus either propanil, halosulfuron, or carfentrazone. All other treatments controlled hemp sesbania 77% or less.

By 42 DAT, barnyardgrass control was 90% or greater except from clomazone EPOST alone at 0.67 kg/ha (84%) and clomazone at 0.25 kg/ha PRE fb propanil plus quinclorac LPOST (85%) (Table 4). Annual sedge control at 42 DAT was generally improved relative to 14 DAT; control increased possibly with the addition of flood establishment. Sequential applications of clomazone tank mixed with either propanil, halosulfuron, or propanil plus quinclorac controlled annual sedge better than clomazone alone. Maximum hemp sesbania control (95%) at 42 DAT occurred from clomazone fb clomazone plus quinclorac. Two other treatments, clomazone fb clomazone plus halosulfuron and clomazone fb propanil plus quinclorac, controlled hemp sesbania > 91%. All other treatments controlled hemp sesbania 72 to 85%.

All treatments increased rice yield relative to the nontreated control; differences among treatments were not detectable (Table 4).

In summary, clomazone can be applied EPOST alone without causing substantial injury to rice. Clomazone can be mixed with other commonly used herbicides without excessive crop injury, while providing adequate weed control and optimal yields. On coarse-textured soils, greater injury was observed from PRE treatments of clomazone compared to EPOST applications. Broadleaf signalgrass and annual sedge control was similar between timings. On heavier soils at Beaumont (clay loam) with greater sedge and hemp sesbania pressure, the addition of a broadleaf herbicide was required for season-long control. Clomazone alone does not provide adequate broadleaf or sedge control and resulted in lower rice yields. Before 2007, clomazone was not labeled on coarse-textured (light) soils in rice because of the level of chlorosis/bleaching observed after application (Anonymous 2007). O'Barr et al. (2007) and the current research provide data supporting EPA approval for a Section 3 label allowing PRE and EPOST clomazone applications on lighter soils. This and other research also provide support for approval of a Section 24C label allowing aerial application of clomazone EPOST tank mixes. Replacing a PRE fb EPOST application program with a single application timing at EPOST will reduce time as well as equipment and fuel expenses. Continued research is needed for reregistration of the Section 24C label annually.

Sources of Materials

¹ Crop oil concentrate, Agri-Dex®, a nonionic spray adjuvant consisting of a blend of heavy paraffin based petroleum oil, ployol

fatty acid esters, and polyethoxylated derivatives. Helena Chemical Company, 6075 Poplar Avenue, Suite 500, Memphis, TN 38119.

² Silicon based surfactant, Kinetic®, a blend of polyalkyleneoxide modified polydimethylsiloxane and polyoxypropylene-polyoxyethylene block copolymers; Helena Chemical Company, 6075 Poplar Avenue, Suite 500, Memphis, TN 38119.

³ Small-plot grain harvester, Kubota Skyrod RX 1450, Kubota Manufacturing of America Corporation, 2715 Ramsey Road, Gainesville, GA 30501.

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Received March 23, 2008, and approved June 19, 2008.