BENZOBICYCLON APPLICATION TIMING IN WATER-SEEDED RICE PRODUCTION

Matthew Osterholt[1], Eric P. Webster[2], Benjamin M. McKnight[3], Gustavo M. Teló[4], Sam Y. Rustom, Jr.[5], L. Connor Webster[6]

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INTRODUCTION

Both dry-seeded and water-seeded planting practices are employed in Louisiana rice production, with water seeded production accounting for approximately 35% of the planted rice area (Harrell and Saichuk 2014). The water-seeded method of planting rice has been utilized for many years in south Louisiana as a means of early weed suppression by creating a soil environment that reduces germination of red rice and several other species of weeds, barnyardgrass [Echinochloa crus-galli (L.) P. Beauv], ducksalad [*Heteranthera limosa* (Sw.) Willd.], yellow nutsedge [Cyperus esculentus] (Dunand et al. 1985). Since the early 1990's, numerous cases of herbicide resistant weeds, to several different modes of actions have been documented and confirmed in the U.S. Benzobicyclon is a 4-hydroxyphenylpyruvate dioxygenase inhibiting herbicide that has been labeled for use in Japan since 2001 (Komatsubara et al. 2009). Past research has indicated benzobicyclon is effective on susceptible weed species when applied at preemergence (PRE) or postemergence following the establishment of the flood (POSTFLOOD) (Sekino et al. 2008). Benzobicyclon applied directly to flood water can be taken up by plants mainly through root and shoot tissue. Because of the unique water activity properties of benzobicyclon and a favorable ecotoxicological profile, this product could be a useful herbicide in Louisiana water-seeded production for the control of troublesome early-season weeds. The objective of this research was to evaluate benzobicyclon application timing effects on weed control in water-seeded rice.

MATERIALS AND METHODS

A field study was conducted in the 2013, 2014, and 2015 growing seasons at the LSU AgCenter H. Rouse Caffey Rice Research Station (RRS) near Crowley, Louisiana. 91-cm diameter by 30-cm tall galvanized metal rings were placed randomly near the center of each plot to seal the area contained inside the ring from the rest of the plot area. Using a pinpoint flooding system, rice was hand broadcasted onto the plot area at approximately 112 kg ha^{-1}. Approximately 48 hours after seeding, the flood was drained from the field to allow for rice seedling establishment for approximately five to seven days. When rice reached the pegging growth stage a pinpoint flood was introduced onto the study area at a depth not completely submerging the tip of the coleoptile and raised as rice plants elongated until a final flood depth of 10-cm was achieved. Benzobicyclon was applied at preplant onto dry soil (SURFACE), into the seeding flood 24 hours after seeding (SEED), 24-hours after the draining of the seeding flood (POSTSEED), on pegging rice 24 hours prior to the pinpoint flood establishment (PEG), 24 hours following the establishment of the pinpoint flood (PIN), on three to four leaf rice or mid-postemergence (MPOST), and one to two tiller rice or late postemergence (LPOST), utilizing a CO_2-pressurized backpack sprayer. Experimental design for this field study was a randomized

[1] Graduate Assistant, LSU AgCenter, 104 Sturgis Hall, Baton Rouge, LA 70808 mosterholt@agcenter.lsu.edu
[2] Professor, LSU AgCenter, 104 Sturgis Hall, Baton Rouge, LA 70808
[3] Research Associate, LSU AgCenter, 104 Sturgis Hall, Baton Rouge, LA 70808
[4] Post-Doctoral Researcher, LSU AgCenter, 104 Sturgis Hall, Baton Rouge, LA 70808
[5] Graduate Assistant, LSU AgCenter, 104 Sturgis Hall, Baton Rouge, LA 70808
[6] Graduate Assistant, LSU AgCenter, 104 Sturgis Hall, Baton Rouge, LA 70808

complete block design replicated four times. Herbicide treatments consisted of benzobicyclon applied at a rate of 246 g ha^{-1} at the seven different, previously mentioned application timings. Visual weed control ratings were recorded at 21, 35, and 49 Days after treatment (DAT). Visual weed control ratings were assigned on a scale of 0 to 100%, where 0 = no injury and 100 = complete plant death. The center 0.75 by 3.6 m area of each plot was harvested and adjusted to 12% moisture for yield determination.

RESULTS AND DISCUSSION

Benzobicyclon applied at the PEG and PIN timing controlled barnyardgrass 97 and 94%, respectively, and this control was higher than barnyardgrass treated at the SURFACE and LPOST timings, which controlled barnyardgrass 64 and 61%, respectively (Table 1). At the SURFACE application timing benzobicyclon was applied on dry soil before the seeding flood was established, which may explain the reduced barnyardgrass control since this herbicide must undergo a conversion hydrolysis reaction from benzobicyclon to benzobicyclon-hydrolysate (Komatsubara et al. 2009). An evaluation timing interaction occurred for the control of barnyardgrass (Table 2); therefore, data were averaged over application timing. At 21 DAT, barnyardgrass control was 72%; however, barnyardgrass control at the time of the final evaluation timing, 49 DAT, increased to 82%.

A herbicide application timing by evaluation timing interaction occurred for the control of yellow nutsedge (Table 3). At 21 DAT, yellow nutsedge treated with benzobicyclon at the SURFACE, MPOST, and LPOST application timings was controlled 53, 33, and 21%, respectively. Increased yellow nutsedge control of 95% was observed at 21 DAT when benzobicyclon was applied at the PEG application timing. At 35 and 49 DAT, yellow nutsedge control from benzobicyclon application at the PEG timing was 98 and 97%, respectively. This level of yellow nutsedge control from the PEG timing was increased over control observed from SURFACE and LPOST applications at 35 and 49 DAT. The SURFACE application was applied to dry soil and the lack of water for the necessary conversion reaction to occur (Komatsubara et al. 2009) may explain reduced yellow nutsedge control from this application timing.

A herbicide application timing by evaluation timings interaction occurred for ducksalad control (Table 4). At 21, DAT ducksalad control was 96% from benzobicyclon applied at the PIN timing, and was increased compared to control observed from the SURFACE, SEED, POSTSEED and PEG application timing which was 72, 67, 61, and 66%, respectively. By 49 DAT, ducksalad control from benzobicyclon application at the SURFACE and PIN timing was 93 and 95%, respectively, and was higher when compared with ducksalad control from the PEG application timing with 69%. Ducksalad control was greater than 90% at all evaluation timings from benzobicyclon applied at the PIN timing, indicating early application into the permanent flood is needed to achieve the most consistent ducksalad control. Ducksalad was smaller at this application timing compared with later timings (Table 2.1), and small weed size in concert with application into the permanent flood may explain ducksalad control greater than 90% at all evaluation timings.

Table 1. Control of barnyardgrass when treated with benzobicyclon at 246 g ha^{-1} at different application timings, averaged across evaluation timings

	Barnyardgrass control
Application Timing	——————— % ———————
SURFACE	64 b
SEED	70 ab
POSTSEED	82 ab
PEG	97 a
PIN	94 a
MPOST	72 ab
LPOST	61 b

Table 2. Control of barnyardgrass at different evaluation timings following treatment with benzobicyclon at 246 g ha^{-1}, averaged over application timings.

Evaluation timing	Barnyardgrass control
—— DAT ——	———————— % ————————
21	72 b
35	79 a
49	82 a

Table 3. Control of yellow nutsedge when treated with benzobicyclon at 246 g ha^{-1} at different application timings across three evaluation dates.

Application timing	Yellow nutsedge contro		
	21 DAT	35 DAT	49 DAT
	———————————— % ————————————		
SURFACE	53 d-g	56 c-g	64 b-e
SEED	61 b-e	71 a-e	78 a-d
POSTSEED	65 b-e	80 a-d	90 abc
PEG	95 ab	98 a	97 a
PIN	63 b-f	92 abc	96 ab
MPOST	33 ej	78 a-d	79 a-d
LPOST	21 g	59 c-f	66 b-e

Table 4. Control of ducksalad when treated with benzobicyclon at 246 g ha^{-1} at different application timings across three evaluation dates.

Application timing	Ducksalad control		
	21 DAT	35 DAT	49 DAT
	———————— % ————————		
SURFACE	72 cd	78 bcd	93 ab
SEED	67 cd	72 cd	89 abc
POSTSEED	61 cd	66 cd	75 bcd
PEG	66 cd	66 cd	69 cd
PIN	96 a	95 ab	95 ab
MPOST	81 abc	83 abc	83 abc
LPOST	75 bcd	80 abc	81 abc

CONCLUSION

The scope of this study was to evaluate benzobicyclon in a simulated water-seeded production system specifically utilizing a pinpoint flood. Benzobicyclon applied at the PEG and PIN timings provided the best control for barnyardgrass with a timing interaction that gave added control of barnyardgrass throughout 49 DAT. Yellow nutsedge was controlled at the PEG timing. This trial demonstrates that ducksalad activity can be obtained from benzobicyclon, and application made immediately after the permanent flood establishment can provide ducksalad control greater than 90%.

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