

# HERBICIDE-RESISTANT WEEDS

Weed resistance is defined by the Weed Science Society of America (WSSA) as the inherited ability of a plant to survive and reproduce after exposure to a dose of herbicide normally lethal to the wild type. In a plant, resistance may be naturally occurring or induced by such techniques as genetic engineering or selection of variants produced by tissue culture or mutagenesis (WSSA). Repeated application(s) of the same herbicide or a different herbicide with similar mode of action on the same field growing season after growing season has contributed to the widespread occurrence of resistance to herbicides in several weed species around the world, in the U.S., and in Mississippi (see list below). Weed management programs must not be solely dependent on herbicides in order to be economically sustainable in the long term. In general, a combination of the following strategies is recommended:

- (1) Use residual herbicides;
- (2) Practice crop rotation;
- (3) Rotate herbicides with different modes of action;
- (4) Tank-mix herbicides with different modes of action at full recommended rates;
- (5) Avoid sequential applications of the same herbicide continually;
- (6) Utilize tillage, cultivation, and other cultural practices wherever and whenever feasible;
- (7) Clean equipment thoroughly before and after each use; and
- (8) Control weeds postharvest to reduce soil seedbank.

## HERBICIDE-RESISTANT WEEDS IN MISSISSIPPI

<b>Weed</b>	<b>Herbicide</b>
Barnyardgrass/Junglerice	propanil, quinclorac
Common cocklebur	MSMA, DSMA, imazaquin, imazethapyr
Goosegrass	trifluralin, pendimethalin, MSMA, DSMA, glyphosate
Johnsongrass	trifluralin, pendimethalin, fluazifop, quizalofop, fenoxaprop, glyphosate
Annual (Italian) ryegrass	metsulfuron, sulfometuron, imazapic, imazapyr, glyphosate, diclofop, pyroxsulam, mesosulfuron
Annual bluegrass	atrazine, simazine
Pigweed species	sulfometuron
Horseweed (mare's-tail)	glyphosate, paraquat
Palmer amaranth	glyphosate, pyriithiobac
Tall waterhemp	glyphosate
Giant ragweed	glyphosate

## **Management Options for Glyphosate-Resistant Weeds in Corn**

These are suggested options for management of glyphosate-resistant weeds in corn. These are not the only options, but they have proven to be effective at managing glyphosate-resistant weeds in corn in Mississippi. Please see the overall herbicide resistance summary in this section for details on existing herbicide-resistant weeds and their distribution in Mississippi.

<b>Weed</b>	<b>Herbicide(s)</b>	<b>Rate</b>	<b>Timing of application</b>	<b>Special instructions</b>
Horseweed	Valor	2 oz/A	Fall to spring burndown but 30 days before planting conventional tillage corn; 1 inch or more of rain must occur between application and planting	Apply before horseweed emerges. If horse weed has emerged, add 2,4-D or dicamba to Valor. Add nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v when tank-mixing with 2,4-D or dicamba.
Horseweed	2,4-D	Formulation dependent	Fall to spring burndown but 7 to 14 days before planting  May also be applied from emergence until corn reaches 8 inches	Apply alone or with residual product listed above for control of horseweed emerged at time of application. 2,4-D provides no residual horseweed control. It is often applied with glyphosate or glyphosate plus residual herbicide in a spring burndown program.  Postemergence applications of 2,4-D may cause some injury such as lodging, bending, and brittleness. Stalks remain brittle for 5 to 7 days after application, during which time they are susceptible to breakage by high winds and cultivation.
Horseweed	dicamba (Banvel, Clarity or other formulation)	Formulation dependent	Fall to spring burndown  May also be applied any time from emergence until corn reaches 36 inches	Apply alone or with residual product listed above for control of horseweed emerged at time of application. Dicamba provides no residual horseweed control. It is often applied with glyphosate or glyphosate plus residual herbicide in a spring burndown program.  Do not add crop oil concentrate to dicamba applied after crop emergence as crop injury may result.
Horseweed	Sharpen	2–3 oz/A, depending on soil texture	Fall to spring burndown up to corn emergence	<b>Horseweed should be less than 6 inches in height or diameter.</b> Sharpen may be applied with glyphosate, paraquat, or Ignite to improve grass and broadleaf weed control. Always add methylated seed oil (MSO) at 1% v/v. Addition of AMS at 1–2% v/v is recommended. Do not apply more than 6 ounces per acre per season.
Horseweed	Ignite 280 SL	22–36 oz/A	Fall to spring burndown but before corn emergence	Ignite is often applied at planting as a salvage treatment. Level of control is dependent on size and age of horseweed, spray coverage, and air temperature. Daytime air temperatures should be at least 70°F at application and for at least 3 to 4 days after application.
Horseweed	atrazine (4 lb/gal liquid formulation)	1.5–2 qt/A	Apply any time from 14 days before planting until corn reaches 12 inches	Atrazine is a restricted-use pesticide. Atrazine may be applied with glyphosate, paraquat, or Ignite to improve grass and broadleaf weed control before corn emergence. Add crop oil concentrate at 1% v/v if applying alone or with a glyphosate formulation not preloaded with an adjuvant.
Horseweed	Lexar	1.67–3 qt/A, depending on soil texture	Apply any time from 14 days before planting until corn reaches 12 inches	Lexar may be applied with glyphosate, paraquat, or Ignite to improve grass and broadleaf weed control before corn emergence. Add nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v if applying alone or with a glyphosate formulation not preloaded with an adjuvant.

Weed	Herbicide(s)	Rate	Timing of application	Special instructions
Horseweed	Halex GT	3.6 pt/A	Apply any time from emergence until corn reaches 30 inches	Add nonionic surfactant at 0.25% v/v. The addition of atrazine may improve postemergence control. Application should be made before corn reaches 12 inches if atrazine is mixed with Halex GT.
Italian ryegrass	Dual Magnum	1.33–1.66 pt/A, depending on soil texture	Fall before Italian ryegrass emergence	Rate is soil-type dependent. Use the higher rate on heavier-textured soils. Apply with paraquat at 0.75 pound of active ingredient per acre if Italian ryegrass is emerged at application. Paraquat should be applied in at least 15 gallons of water by ground and with nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v.
Italian ryegrass	clethodim (Select Max or 2 lb/gal formulation)	12–16 oz/A of Select Max or 6–8 oz/A of 2 lb/gal formulation	Apply to small Italian ryegrass before it exceeds 6 inches in height; apply in early burndown program (late January to early February); <b>do not apply within 30 days of corn planting</b>	<b>Multiple applications of clethodim are not recommended.</b> Do not apply under cold conditions. Daytime temperatures should be at least 60°F at application and for at least 3 to 4 days after application. Add nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v if applying alone or with a glyphosate formulation not preloaded with an adjuvant. <b>Sequential application of paraquat will be required if no fall residual was applied.</b>
Italian ryegrass	paraquat	3–4 pt/A of 2 lb/gal formulation or 2–2.67 pt/A of 3 lb/gal formulation	Apply to emerged Italian ryegrass; apply mid-February to early March	Spray volume is critical. Paraquat should be applied in at least 15 gallons of water by ground and with nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v. Avoid application with air induction nozzles. Paraquat does not provide residual control. Apply with atrazine to improve postemergence Italian ryegrass activity. <b>For spring burndown, paraquat should be applied 2 to 4 weeks after clethodim treatment if no fall residual was applied.</b>
Palmer amaranth	atrazine (4 lb/gal liquid formulation)	1.5–2 qt/A	Apply any time from 14 days before planting until corn reaches 12 inches	Atrazine is a restricted-use pesticide. It may be applied with glyphosate, paraquat, or Ignite to improve grass and broadleaf weed control before corn emergence. Add crop oil concentrate at 1% v/v if applying alone or with a glyphosate formulation not preloaded with an adjuvant.
Palmer amaranth	Cinch ATZ	4.2–5.2 pt/A, depending on soil texture	After planting	Control is dependent on activation of herbicide and level of weed infestation. Use the higher rate on heavier-textured soils. Apply with paraquat at 0.5–0.75 pound of active ingredient per acre if Palmer amaranth is emerged at application. Paraquat should be applied in at least 15 gallons of water by ground and with nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v.
Palmer amaranth	Degree Xtra	2.9–3.7 qt/A, depending on soil texture	After planting	Control is dependent on activation of herbicide and level of weed infestation. Use the higher rate on heavier-textured soils. Apply with paraquat at 0.5–0.75 pound of active ingredient per acre if Palmer amaranth is emerged at application. Paraquat should be applied in at least 15 gallons of water by ground and with nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v.

<b>Weed</b>	<b>Herbicide(s)</b>	<b>Rate</b>	<b>Timing of application</b>	<b>Special instructions</b>
Palmer amaranth	Guardsman Max	2.5, 3, or 4 pt/A, depending on soil texture	After planting	Control is dependent on activation of herbicide and level of weed infestation. Use the higher rate on heavier-textured soils. Apply with paraquat at 0.5–0.75 pound of active ingredient per acre if Palmer amaranth is emerged at application. Paraquat should be applied in at least 15 gallons of water by ground and with nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v.
Palmer amaranth	Lexar	1.67–3 qt/A, depending on soil texture	After planting	Control is dependent on activation of herbicide and level of weed infestation. Use the higher rate on heavier-textured soils. Apply with paraquat at 0.5–0.75 pound of active ingredient per acre if Palmer amaranth is emerged at application. Paraquat should be applied in at least 15 gallons of water by ground and with nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v.
		Sequential applications of 1.5–2 qt/A, followed by 1.25–1.75 qt/A	Before corn emergence, followed by application before corn reaches 12 inches	Add nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v if applying alone or with a glyphosate formulation not preloaded with an adjuvant. Total Lexar rate should not exceed 3 quarts per acre in a single season.
Palmer amaranth	Callisto plus atrazine	3 oz/A plus 1.5 qt/A	Apply any time from emergence until corn reaches 12 inches and to Palmer amaranth less than 4 inches	Add crop oil concentrate at 1% v/v if applying alone or with a glyphosate formulation not preloaded with an adjuvant. Total Callisto rate should not exceed 7.7 ounces per acre in a single season.
Palmer amaranth	Laudis plus atrazine	3 oz/A plus 1.5 qt/A	Apply any time from emergence until corn reaches 12 inches and to Palmer amaranth less than 4 inches	Add methylated seed oil (MSO) at 1% v/v if applying alone or with a glyphosate formulation not preloaded with an adjuvant. Total Laudis rate should not exceed 6 ounces per acre in a single season.
Palmer amaranth	Halex GT plus atrazine	3.6 pt/A plus 1.5 qt/A	Apply any time from emergence until corn reaches 12 inches and to Palmer amaranth less than 4 inches	Add nonionic surfactant at 0.25% v/v.
Palmer amaranth	dicamba (Banvel, Clarity or other formulation)	Formulation dependent	Apply any time from emergence until corn reaches 36 inches and to Palmer amaranth less than 4 inches	Do not add crop oil concentrate to dicamba applied after crop emergence as crop injury may result. Dicamba may be applied with glyphosate to improve grass and broadleaf weed control.
Palmer amaranth	2,4-D	Formulation dependent	Apply any time from emergence until corn reaches 8 inches	Postemergence applications of 2,4-D may cause some injury such as lodging, bending, and brittleness. Stalks remain brittle for 5 to 7 days after application, during which time they are susceptible to breakage by high winds and cultivation.
Palmer amaranth	Ignite 280 SL	22 oz/A	Apply any time from emergence to V5 growth stage; Palmer amaranth should not exceed 3 to 6 inches	For use on Liberty Link corn only. Do not apply more than two applications per season. Sequential applications should be made 10 to 14 days apart. Apply in at least 10 gallons of water. Avoid application with air induction nozzles. Total Ignite rate should not exceed 44 ounces per acre in a single season.

<b>Weed</b>	<b>Herbicide(s)</b>	<b>Rate</b>	<b>Timing of application</b>	<b>Special instructions</b>
Johnsongrass (rhizome)	Accent	0.67–1.33 oz/A, depending on johnsongrass size at application	Apply to 12- to 18-inch johnsongrass	Apply in at least 10 gallons of water by ground. Add nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v if applying alone or with a glyphosate formulation not preloaded with an adjuvant. If applied with glyphosate formulation preloaded with an adjuvant, no additional adjuvant is required. Do not make more than two applications of Accent in a single season.
Johnsongrass (rhizome)	Stout	0.5–0.75 oz/A, depending on johnsongrass size at application	Apply to 6- to 18-inch johnsongrass	Apply in at least 10 gallons of water by ground. Add nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v if applying alone or with a glyphosate formulation not preloaded with an adjuvant. If applied with glyphosate formulation preloaded with an adjuvant, no additional adjuvant is required. Do not make more than one application of Stout in a single season.

## **Management Options for Glyphosate-Resistant Weeds in Cotton**

These are suggested options for management of glyphosate-resistant weeds in cotton. These are not the only options, but they have proven to be effective at managing glyphosate-resistant weeds in cotton in Mississippi. Please see the overall herbicide resistance summary in this section for details on existing herbicide-resistant weeds and their distribution in Mississippi.

<b>Weed</b>	<b>Herbicide(s)</b>	<b>Rate</b>	<b>Timing of application</b>	<b>Special instructions</b>
Horseweed	diuron (4 lb/gal liquid formulation)	1, 2, or 3.2 pt/A, depending on soil texture	Fall to spring burndown	Apply before horseweed emerges. If horseweed has emerged, add 2,4-D, dicamba, or Ignite 280 SL to diuron. Add nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v when tank-mixing with 2,4-D or dicamba. Use the higher rate on heavier-textured soils. <b>A postemergence application will likely be required for control of horseweed emerging in spring.</b>
Horseweed	Envoke	0.15 oz/A	Fall to spring burndown but 3 months before planting	Apply before horseweed emerges. If horseweed has emerged, add 2,4-D, dicamba, or Ignite 280 SL to Envoke. Add nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v when tank-mixing with 2,4-D or dicamba.
Horseweed	Valor	2 oz/A	Fall to spring burndown but 30 days before planting conventional tillage cotton; 1 inch or more of rain must occur between application and planting	Apply before horseweed emerges. If horseweed has emerged, add 2,4-D or dicamba to Valor. Add nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v when tank-mixing with 2,4-D or dicamba.
Horseweed	2,4-D	Formulation dependent	Fall to spring burndown but 30 days before planting	Apply alone or with residual product listed above for control of horseweed emerged at time of application. 2,4-D provides no residual horseweed control. It is often applied with glyphosate or glyphosate plus residual herbicide in a spring burndown program.
Horseweed	dicamba (Banvel, Clarity or other formulation)	Formulation dependent	Fall to spring burndown; must wait at least 21 days before planting cotton following 1 inch or more of rain after application	Apply alone or with residual product listed above for control of horseweed emerged at time of application. Dicamba provides no residual horseweed control. It is often applied with glyphosate or glyphosate plus residual herbicide in a spring burndown program.
Horseweed	Sharpen	1 oz/A	Fall to spring burndown; must wait at least 42 days before planting cotton following 1 inch or more of rain after application	<b>Horseweed should be less than 4 inches in height or diameter.</b> Sharpen may be applied with glyphosate, paraquat, or Ignite to improve grass and broadleaf weed control. Always add methylated seed oil (MSO) at 1% v/v. Addition of AMS at 1–2% v/v is recommended. Do not apply more than 2 ounces per acre per season.
Horseweed	Ignite 280 SL	22–36 oz/A	Fall to spring burndown but before cotton emergence	Ignite is often applied at planting as a salvage treatment. Level of control is dependent on size and age of horseweed, spray coverage, and air temperature. Daytime air temperatures should be at least 70°F at application and for at least 3 to 4 days after application.
Italian ryegrass	Dual Magnum	1.33–1.66 pt/A, depending on soil texture	Fall before Italian ryegrass emergence	Use the higher rate on heavier-textured soils. Apply with paraquat at 0.75 pound of active ingredient per acre if Italian ryegrass is emerged at application. Paraquat should be applied in at least 15 gallons of water by ground and with nonionic surfactant at 0.25% v/v or crop oil concentrate at 1% v/v.