REDUCING SELECTION PRESSURE FOR PPO RESISTANCE IN NO-TILL COTTON

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Abstract

Widespread resistance to glyphosate and ALS-inhibiting herbicides in Palmer amaranth (*Amaranthus palmeri*) has led to greater reliance on PPO-inhibiting herbicides. One of the most effective strategies for managing glyphosate-resistant Palmer amaranth in no-till cotton includes an early preplant (EPP) application of flumioxazin followed by a PRE application of fomesafen, both of which are PPO inhibitors. Extensive use of PPO inhibitors in cotton and other crops is reason for concern over possible resistance to this mode of action. This is especially the case where PPO inhibitors are used EPP and PRE in the same season. Currently, populations of common waterhemp (*Amaranthus tuberculatus* syn. *rudis*), common ragweed (*Ambrosia artemisiifolia*), and wild poinsettia (*Euphorbia heterophylla*) resistant to PPO-inhibiting herbicides have been confirmed. The objective of this research was to determine if diuron is a suitable alternative to one PPO-inhibiting herbicide in no-till production systems.

The experiment was conducted in North Carolina near Rocky Mount and Mount Olive during 2010, 2011, and 2012. Soils included Aycock sandy loam with 0.5% humic matter and pH 5.7 at Rocky Mount and Wagram loamy sand with 0.3% humic matter and pH 5.2 at Mount Olive. Diuron at 0.75 lb ai/acre, flumioxazin at 0.064 lb ai/acre, or no residual herbicide plus paraquat at 0.75 lb ai/acre were applied EPP 21 to 25 days ahead of planting. Cotton cultivar PHY 375WRF or PHY 499WRF were planted no-till in 2010 and 2011. In 2012, cotton cultivar FM 1944 GLB2 was planted no-till. Paraquat alone at 0.75 lb/acre, paraquat plus diuron at 0.75 lb/acre, and paraquat plus fomesafen at 0.25 lb ai/acre were applied within 2 hours of planting. In 2010 and 2011, all treatments, except checks, included glufosinate ammonium at 0.48 lb ae/acre applied to two-leaf cotton and repeated on eight-leaf cotton. The experiment in 2012 utilized a glyphosate-based POST herbicide program. All treatments, except checks, received glyphosate at 0.77 lb ae/acre applied POST to 1- to 2-leaf cotton and again to 6- to 7-leaf cotton. In all years, prometryn plus trifloxysulfuron plus MSMA at 1.0 plus 0.1 plus 2.0 lb ai/acre were directed to 18- to 20-inch cotton. Checks received only paraquat EPP and PRE. Palmer amaranth control was estimated visually, and plots were harvested mechanically to determine seed cotton yield. Data, with checks deleted, were subjected to analysis of variance using the PROC MIXED procedure of SAS and means were separated using Fishers Protected LSD at $p \leq 0.05$.

In 2010 and 2011, at the time of the two-leaf glufosinate application, flumioxazin applied EPP controlled Palmer amaranth 93 to 99%. Control was not increased by diuron or fomesafen PRE. Diuron EPP and flumioxazin EPP were similarly effective at Rocky Mount in 2011, but diuron EPP controlled Palmer amaranth only 55 to 72% at the other three locations. Diuron PRE and fomesafen PRE, without a residual EPP, were similarly effective both years at Rocky Mount (87 to 93% control). Diuron PRE and fomesafen PRE at Mount Olive controlled Palmer amaranth 50 and 68%, respectively, in 2010 and 96 and 84% in 2011. Control by flumioxazin EPP, flumioxazin EPP plus diuron PRE, and flumioxazin EPP plus fomesafen PRE was similar at all locations (93 to 99%). At 3 of 4 locations, control by diuron EPP plus fomesafen PRE and flumioxazin EPP plus fomesafen PRE was similar (92 to 99%). At one location with limited rainfall after PRE application, diuron EPP plus fomesafen PRE controlled Palmer amaranth 65% compared with 99% control by flumioxazin EPP followed by fomesafen PRE. Differences among systems were less obvious following the two well-timed POST applications of glufosinate. No differences were observed among any systems in 2010 at time of lay-by application. In 2011, systems with EPP plus PRE were more effective than EPP alone or PRE alone. However, no differences were observed among systems with flumioxazin EPP plus fomesafen PRE, flumioxazin EPP plus diuron PRE, and diuron EPP plus fomesafen PRE. Following the lay-by application, good control was noted with all systems. Control late in the season ranged from 91to 97%, with no differences among systems for Palmer amaranth control or seed cotton yield.

In 2012, at the time of the 1- to 2-leaf glyphosate application, flumioxazin alone EPP controlled 71 to 91% of Palmer amaranth and was more effective than diuron alone EPP (41 to 48%). Furthermore, the addition of fomesafen or diuron PRE to flumioxazin EPP improved control of Palmer amaranth at Rocky Mount. However, no increase in control was achieved at Mount Olive with the addition of fomesafen or diuron PRE to flumioxazin EPP. Due to timely activating rainfall in 2012, fomesafen and diuron alone PRE provided greater than 84% control of Palmer amaranth. At lay-by time, Palmer amaranth control by flumioxazin and diuron alone EPP at Rocky Mount was 54 and 45%, respectively. Fomesafen applied PRE alone or following an EPP herbicide provide greater control of Palmer amaranth. At Mount Olive, flumioxazin EPP followed by fomesafen PRE controlled 85% of Palmer amaranth present. All other treatments were equally effective, except diuron applied alone EPP or PRE. All treatments provide equivalent late season control of the weed at Mount Olive. However, at Rocky Mount control of Palmer amaranth by EPP herbicides applied alone (48 to 57%) were less effective than herbicide programs that included a PRE herbicide (87 to 98%). Seed cotton yield followed the same trend at Rocky Mount. When flumioxazin or diuron was applied alone EPP yield approximated 3500 to 3600 lb/acre. Seed cotton yield in plots receiving all other treatments was greater than 5200 lb/acre. At Mount Olive, no differences in seed cotton yield between herbicide treatments were evident. In all years, check plots could not be harvested due to extreme Palmer amaranth infestations.

This research shows the value of residual herbicides as components of burndown systems in no-till cotton. A residual herbicide as part of the burndown program protects growers from poor weed control if PRE herbicides are not activated timely. Flumioxazin and diuron are the only residual options registered in North Carolina for EPP application. Our results suggest flumioxazin is the preferred product. Hence, if one's goal is to limit PPO inhibitors to one application during early season, flumioxazin EPP followed by diuron PRE would be the preferred system. For growers who insist on using flumioxazin EPP and fomesafen PRE, we suggest including another mode of action, such as diuron or fluometuron, with the fomesafen PRE to help prevent selection for resistance to PPO inhibitors.