TITLE: Locating Glyphosate-Resistant Palmer Amaranth in Georgia and North Carolina

DISCIPLINE: Weed Science

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ABSTRACT

A survey was conducted in both Georgia and North Carolina to determine the distribution glyphosate-resistant Palmer amaranth biotype(s). Knowledge of the distribution of glyphosate resistance will alert growers to the severity of the problem and hopefully encourage them to adopt resistance management programs. Glyphosate-resistant Palmer amaranth was detected in 71 fields in 10 Georgia counties and in 49 fields in 11 North Carolina counties.

The world's first confirmed case of glyphosate resistance in an *Amaranthus* species occurred with Palmer amaranth in Georgia during 2005 (Culpepper et al., 2006; Heap, 2007). In the following year, scientists from North Carolina, South Carolina, Tennessee, and Arkansas were all studying suspected populations of glyphosate-resistant Palmer amaranth in their states as well. By 2006, glyphosate-resistant Palmer amaranth was confirmed in North Carolina, with confirmation expected in South Carolina and Arkansas during 2007 (Scott et al., 2007; York et al., 2007).

Glyphosate resistance in Palmer amaranth poses serious ramifications for future weed management (Culpepper et al., 2007; MacRae et al., 2007; Whitaker et al., 2007). Palmer amaranth was already one of the most troublesome weeds of agronomic crops across the southern United States (Webster 2005); resistance to glyphosate will only exacerbate the problem, especially in light of the widespread planting of glyphosate-resistant crops. Additionally, spread of resistance through pollen in this dioecious species (forced outcrossing) likely will be rapid (Sosnoskie et al., 2007).

Initial research indicates that economical management of glyphosate-resistant Palmer amaranth is nearly impossible with currently available technology in crops such as cotton (Culpepper et al., 2007; MacRae et al., 2007; Whitaker et al., 2007). Surveys were conducted in Georgia and North Carolina to determine the distribution of the resistant biotype(s).

MATERIALS AND METHODS

Field Sampling Techniques: Palmer amaranth seedheads were collected in Georgia from 99 fields in three counties during 2005 and from an additional 37 fields in seven counties in 2006 (Figure 1). In North Carolina during the fall of 2005, resistance was suspected in two primary areas (Figure 2) where seed collection focused. However, additional samples were taken throughout the cotton production areas including samples from 290 cotton fields in 29 counties (Figure 3).

Sampling technique included randomly harvesting a minimum of 30 seedheads from female plants spaced at least 10 m apart in infested fields while walking in a zig-zag pattern over the field. Cropping history and herbicide use were unknown for all fields at the time of the survey. Seedheads were placed in paper bags and the GPS (global positioning system) coordinates of the field recorded. Bags containing the seedheads were placed in a greenhouse for drying. Seed were then threshed by hand and stored at 1 C until use.

Greenhouse Screening: The screening was conducted during the fall and winter of 2005, 2006, and 2007. Samples from Georgia were screened in a greenhouse in Tifton, GA while those from North Carolina were screened in Raleigh, NC. Greenhouses were maintained at 32$\pm$5 C, and natural light was supplemented for 12 to 14 h each day by metal halide lamps. Due to the large number of samples, all locations within a state could not be screened simultaneously. During

each screening, previously confirmed glyphosate-resistant and -sensitive biotypes of Palmer amaranth were included for comparison. Seed from each location and the control populations were planted separately into flats containing commercial potting media. Seedlings were thinned to 8 to 12 plants per flat within 2 d after emergence. Plants were watered by drip or overhead irrigation and were fertilized as needed to maintain good growth.

Seedlings 7 to 10 cm tall were treated with the potassium salt of glyphosate at 280 and 840 g a.e. ha^{-1}. In a preliminary study, glyphosate at 280 g ha^{-1} controlled sensitive biotypes at least 95% under the aforementioned greenhouse conditions. The higher rate, 840 g ha^{-1}, is the rate normally recommended for postemergence application to cotton under field conditions to control this pest (Anonymous, 2007). The experimental design was a randomized complete block (blocked by plant size) with treatments replicated three times, and the experiment was repeated once. Visible Palmer amaranth control was estimated 21 d after glyphosate application using a scale of 0 to 100, where 0 = no control and 100 = death of all plants (Frans et al., 1986). The following criteria were used in both states to determine resistance: plants controlled less than 50% by glyphosate at 840 g ha^{-1} were considered to be highly resistant; plants controlled less than 50% by glyphosate at 280 g ha^{-1} were considered to have a low level of resistance. A few samples had one or two plants poorly controlled while the remainder died; such samples were considered to be a mixed population, perhaps representing developing populations of glyphosate resistance in that field.

RESULTS AND DISCUSSION

The 10 counties surveyed in Georgia represent an intensive cotton production area containing over 125,000 ha (Boatright and McKissick, 2004). Populations of Palmer amaranth resistant to

glyphosate were found in all 10 counties with 71 of the 136 Georgia fields sampled containing resistance. Palmer amaranth from 33 of these fields was considered highly resistant to glyphosate. Twenty-three fields had Palmer amaranth with a low level of resistance, while 15 fields had mixed populations.

Cotton production in North Carolina is located predominately in the eastern portion of the state. The 28 counties sampled in eastern North Carolina produced 286,000 ha of cotton in 2005 while the four counties in the western portion of the state produced 3,000 ha (NCDACS, 2007). Populations of Palmer amaranth resistant to glyphosate were found in 49 fields, scattered over 11 eastern counties in North Carolina. Of the 49 fields with glyphosate-resistance, 10 had a high level of resistance, 30 had a low level, and 9 had mixed populations.

Glyphosate-resistant Palmer amaranth is far more widespread than initially expected. Preventative weed management programs that delay arrival of this resistant pest into non-infested fields, along with aggressive management programs in fields currently infested, will be critical for sustainable production of glyphosate-resistant cotton.

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Figure 1. Georgia counties sampled for glyphosate-resistant Palmer amaranth in 2005 and 2006. Number within a county is the number of fields sampled.

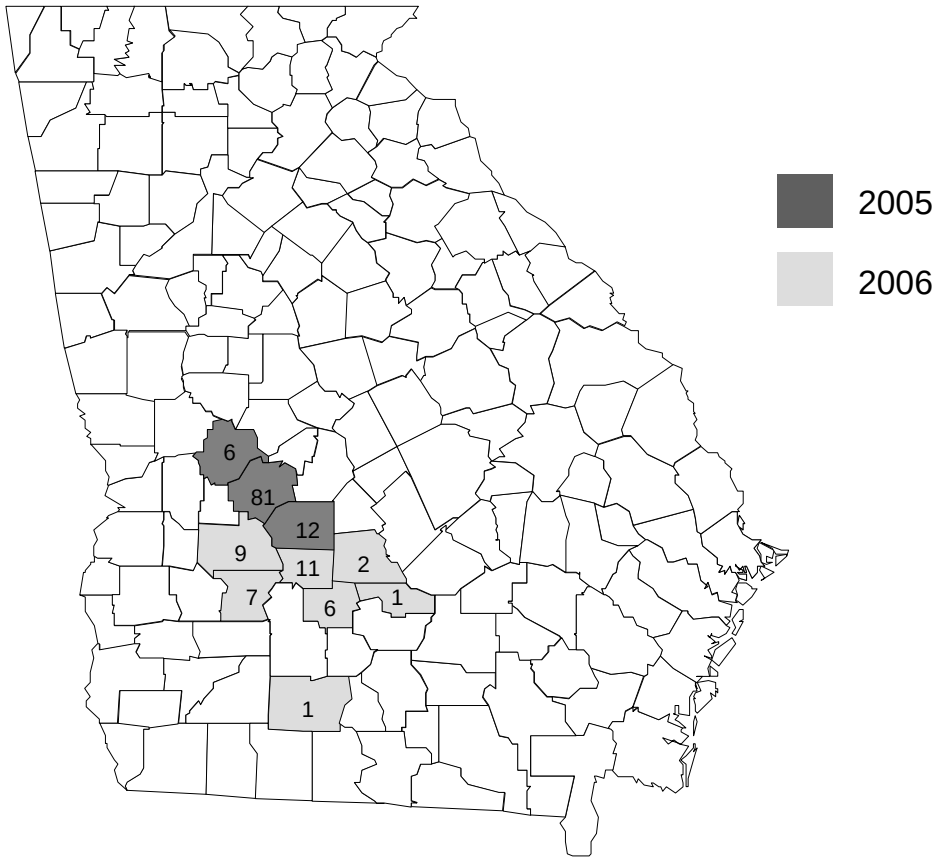

Figure 2. Glyphosate resistance initially suspected in seven fields in Hoke, Robeson, and Wayne counties during 2005 in North Carolina.

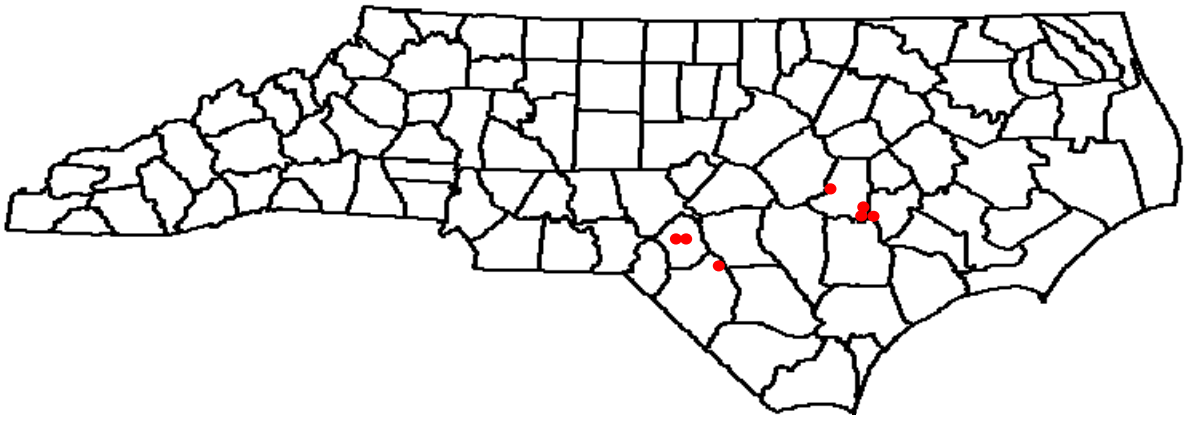

Figure 3. North Carolina counties sampled for glyphosate-resistant Palmer amaranth in 2005. Number within a county is the number of fields sampled.