Peanut Response to Ethalfluralin: Rates and Methods of Application[1]

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ABSTRACT

Studies were conducted in 1994 and 1995 at Headland, AL, Gainesville, FL, and Tifton, GA to quantify peanut injury by ethalfluralin applied preplant incorporated (PPI) or preemergence (PRE) at 0.0, 0.6, 1.1, 2.2, and 4.5 kg ai/ha. Parameters most sensitive to ethalfluralin injury were pod biomass and yield, while time of emergence, stand, canopy width, and foliar biomass were less sensitive. Ethalfluralin was generally more injurious when applied PPI than PRE, especially when rates were ≥ 2.2 kg/ha. At these rates, pod formation was inhibited and yields were reduced with little corresponding effect on vegetative growth. These data show ethalfluralin can be safely applied either PPI or PRE to peanut at rates ≤ 1.1 kg/ha.

Key Words: *Arachis hypogaea* L., herbicide phytotoxicity, peanut injury.

Dinitroaniline herbicides are widely used on an array of agronomic and horticultural crops for control of annual grasses and small-seeded broadleaf weeds. Dinitroaniline herbicides are soil applied and absorbed by roots and emerging shoots, inhibiting root growth by arresting mitosis (Appleby *et al.*, 1989). While considered to be among the least phytotoxic herbicides to dicot crops (Hamilton and Arle, 1976; Keeling *et al.*, 1996), there is considerable variation in crop tolerance among dinitroaniline herbicides (Murray *et al.*, 1973, 1979; Buchanan *et al.*, 1978; Jordan *et al.*, 1978).

Dinitroaniline herbicides are normally applied preplant incorporated (PPI), but some may be applied preemergence (PRE) or injected through overhead irrigation systems. Dinitroaniline herbicides are volatile, although the potential for volatility loss varies according to chemical structure, depth of incorporation, time of incorporation, and soil moisture (Bardsley *et al.*, 1968;

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Oliver and Frans, 1968; Menges and Tamez, 1974; Kennedy and Talbert, 1977; Weber, 1990). Dinitroaniline herbicides have low water solubility and are adsorbed to soil organic matter and clay, making them immobile in the soil (Weber, 1990). Therefore, dinitroaniline herbicides remain where they are initially placed by mechanical incorporation, irrigation, or rainfall (Jordan *et al.*, 1963; Menges and Tamez, 1974).

Dinitroaniline herbicides are widely used on peanut throughout the U.S., and many were evaluated on peanut in the 1960s and 1970s. Benefin [*N*-butyl-*N*-ethyl-2,6-dinitro-4-(trifluoromethyl)benzenamine] was efficacious and safe to use on peanut (Guse *et al.*, 1966), and it eventually became the first dinitroaniline herbicide widely used on peanut. However, Greer *et al.* (1969) reported a "narrow margin of safety" with trifluralin [2,6-dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine] and nitralin [4-(methylsulfonyl)-2,6-dinitro-*N*,*N*-dipropylbenzenamine] on spanish-type peanut, with application rate and depth of incorporation influencing crop injury. Later research included other dinitroaniline herbicides (Buchanan *et al.*, 1978; Brecke and Currey, 1980; Grichar and Colburn, 1993), and some were effective for weed control in peanut with no noticeable differences in phytotoxicity among peanut cultivars. These studies led to registrations of ethalfluralin [*N*-ethyl-*N*-(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl) benzenamine], pendimethalin [*N*-(1-ethylpropyl)-3,4 dimethyl-2,6 dinitrobenzenamine], and trifluralin applied PPI on peanut.

With increased interest in conservation tillage and stale seedbed weed control in all crops, including peanut, alternatives to dinitroaniline herbicides applied PPI are being considered. Even in conventional crop production systems, dinitroaniline herbicides applied PRE have advantages over PPI applications. For example, the cost of using center-pivot irrigation to activate PRE herbicides was approximately $1.60/ha in 1996 (C. C. Dowler, pers. commun., 1997) while the cost of incorporation with a disk-harrow was approximately $3.20/ha (Givan and Shurley, 1995). Without irrigation or timely rainfall for activation, dinitroaniline herbicides applied PRE perform inconsistently (Byrd and York, 1987). Other herbicides have been successfully applied PRE and activated with irrigation without loss in efficacy or increased injury compared with PPI applications (Jordan *et al.*, 1963; Gasper *et al.*, 1994).

Early season dinitroaniline herbicide injury is often expressed as overall stunting, swollen hypocotyls, and abnormal lateral root growth (Buchanan *et al.*, 1978). This injury can be confounded by cool temperatures and poor seed quality. Occasionally, dinitroaniline herbicide injury is not detected until harvest. In these cases, peanut vegetative growth appears unaffected. However, injured plants often have large numbers of gynophores and very few pods (Merkle, 1975; Buchanan *et al.*, 1978). It appears that the unique process of peanut gynophores forming above ground, penetrating the soil surface, and forming pods subsurface may predispose peanut to injury from dinitroaniline herbicides that accumulate near the soil surface.

Documented injury to peanut from dinitroaniline herbicides at registered rates is rare (Buchanan *et al.*, 1978; Grichar and Colburn, 1993). However, situations occasionally arise where dinitroaniline herbicides are suspected to injure peanut. Specifically, a peanut field in Crisp County, GA in 1986 had severe herbicide injury (W. C. Johnson III, pers. observation). In this case, peanut vegetative growth was seemingly normal late in the growing season, but pod formation was completely inhibited. Ethalfluralin was reportedly used PRE and activated with irrigation. While the reasons for this injury case were never definitively identified, nonregistered PRE applications of ethalfluralin and excessive rates were suspected.

In order to expand the utility of dinitroaniline herbicides, the rare occurrences of phytotoxicity on peanut need to be explained with respect to PRE applications. Therefore, multi-state cooperative case studies were conducted to quantify the phytotoxicity of ethalfluralin applied PPI and PRE on peanut.

Materials and Methods

Field studies were conducted in 1994 and 1995 at the Wiregrass Substation near Headland, AL, Archer Farm near Gainesville, FL, and Coastal Plain Exp. Stn. near Tifton, GA. The soil at Headland was a Dothan loamy sand (thermic Plinthic Paleudults); pH 6.1, 83% sand, 7% silt, and 10% clay with 1.2% organic matter. The soil at Gainesville was an Arrendondo fine sand (hyperthermic Grossarenic Paleudults); pH 6.4, 86% sand, 10% silt, and 4% clay with 0.5% organic matter. The soil at Tifton was a Tifton loamy sand (thermic Plinthic Kandiudults); pH 6.5, 92% sand, 2% silt, and 6% clay with 0.5% organic matter in 1994 and pH 6.4, 86% sand, 8% silt, and 6% clay with 0.9% organic matter in 1995.

The experimental design was a split-plot with treatments replicated four times. Main plots were times of ethalfluralin application, either PPI or PRE. Ethalfluralin applied PPI was incorporated to a depth of 7.6 cm with a power tiller. Plots treated with ethalfluralin applied PRE were also tilled with a power tiller before planting. Ethalfluralin was applied PRE immediately after planting. All plots were irrigated immediately after herbicide application in Florida and Georgia, while rainfall activated PRE treatments in Alabama. Irrigation equipment varied between locations and years, with cable-tow and overhead sprinkler systems being used. Irrigation volumes varied from 1.0 to 1.8 cm. Rainfall (0.1 to 0.6 cm) occurred within 4 d after herbicide application in Alabama both years.

Subplots were ethalfluralin rates of 0.0, 0.6, 1.1, 2.2, and 4.5 kg/ha, which encompass rates registered on peanut and other leguminous crops. The registered rate of ethalfluralin PPI on coarse textured soils is 0.8 kg /ha. Herbicides were applied with a tractor-mounted compressed-air plot sprayer calibrated to deliver 234 L/ha at 207 kPa with flat fan nozzle tips.

Plots were two rows wide by 6.1 m long. Row spacing was 91 cm in Alabama and Georgia and 76 cm in Florida. The cultivars were Florunner, Sunrunner, and Georgia Runner in Alabama, Florida, and Georgia, respectively. These cultivars are among the most commonly planted cultivars in the Southeastern U.S. Previous research did not identify differences in dinitroaniline herbicide sensitivity among peanut cultivars (Buchanan *et al.*, 1978). Different cultivars among the three locations in our trials would not be expected to affect the results.

All plots were maintained weed free throughout the growing season. Weeds were pulled by hand, with every effort made to avoid displacing the treated soil. Only nontreated plots were hoed or cultivated. Otherwise, cultural, insect, and disease management practices were based on recommendations by the Alabama, Florida, and Georgia Cooperative Extension Services.

Parameters measured were time of seedling emergence (observation), stand, canopy width, midseason pod and foliage biomass, and yield. Stands and canopy width at Gainesville were measured 48 and 30 d after emergence (DAE) in 1994 and 1995, respectively. Stands and canopy width at Tifton were measured 33 and 30 DAE in 1994 and 1995, respectively. Midseason biomass at Headland was measured 76 and 85 DAE in 1994 and 1995, respectively. Midseason biomass at Gainesville was measured 95 DAE in 1995. Midseason biomass at Tifton was measured 87 and 85 DAE in 1994 and 1995, respectively. Biomass samples were collected from a 1-m section of row in each plot, separated into pods and foliage, dried at 38 C for 72 hr, and weighed. Peanut yields were measured from the remaining 5.1 m of the plot by digging, inverting, air curing, and combining using commercial two-row implements. Yield samples were mechanically cleaned to remove foreign material.

All data were subjected to analysis of variance ($P \leq 0.05$) and regression analysis. The nonsignificant treatment-by-year and treatment-by-location interactions allowed data pooling over locations and years.

Results and Discussion

Vegetative Growth Response. Time of peanut emergence did not differ between methods of ethalfluralin application or among rates (data not shown). Similarly, peanut stand was not affected by ethalfluralin (data not shown). However, peanut canopy development was inhibited by increasing rates of ethalfluralin applied PPI (Fig. 1A). At rates greater than four times the registered rate of 0.8 kg/ha, ethalfluralin applied PPI reduced canopy width by approximately 6%. In contrast, ethalfluralin applied PRE had no effect on canopy width.

Peanut vegetative growth at midseason responded differently to ethalfluralin applied PPI or PRE (Fig. 1B). There was considerable variation in foliage biomass data, which is often characteristic of this type of quantitative measurement of peanut growth. However, the response of peanut foliage biomass to excessive rates (≥ 2.2 kg/ha) of ethalfluralin shows PPI applications are more inhibitory than equivalent rates applied PRE.

Reproductive Growth Response. There was considerable variation in pod biomass, especially at the lower ethalfluralin rates. However, the response of pod biomass to ethalfluralin was generally similar to vegetative growth response. Pod biomass was inhibited more by ethalfluralin at 4.5 kg/ha applied PPI than the equivalent rate applied PRE (Fig. 2A). Ethalfluralin applied PPI at rates greater than four times the registered rate reduced pod biomass by approximately 30%. In contrast, peanut pod biomass did not differ between ethalfluralin PRE at the registered rate (0.8 kg/ha) and the highest rate evaluated (4.5 kg/ha).

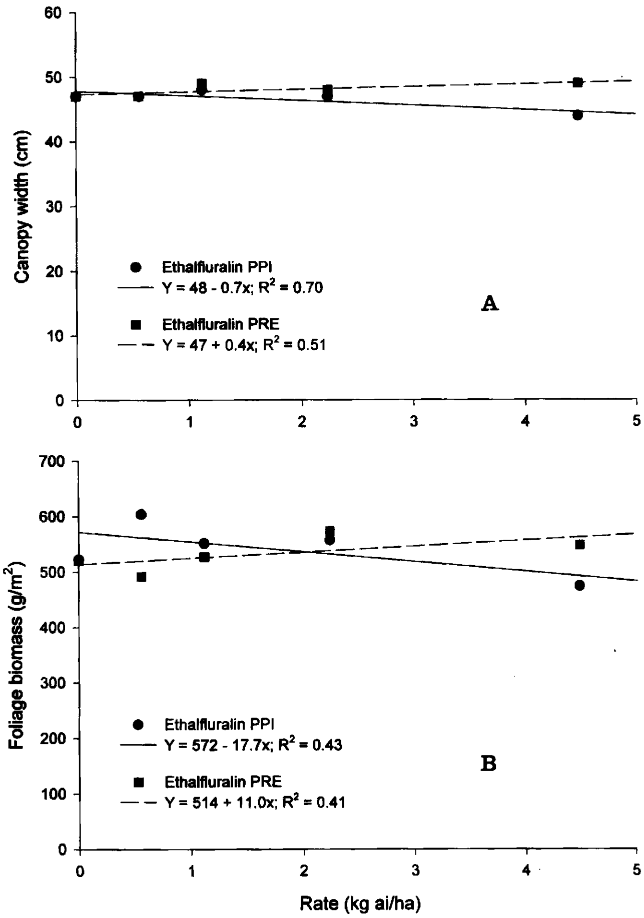

Fig. 1. Effect of ethalfluralin on peanut vegetative growth at Headland, AL; Gainesville, FL; and Tifton, GA, 1994 and 1995. A = canopy width; B = vegetative biomass.

Peanut yield response to ethalfluralin was similar to the response of peanut pod biomass, but with much less variation. Excessive rates of ethalfluralin applied PPI reduced yields more than equivalent rates of ethalfluralin applied PRE (Fig. 2B). Peanut yields were generally not affected by ethalfluralin at rates ≤ 2.2 kg/ha regardless of method of application. However, at rates greater than four times the registered rate, ethalfluralin applied PPI reduced peanut yields by approximately 15%. In contrast, peanut yields were not affected by ethalfluralin applied PRE.

Three general statements can be made from the results of these studies. First, vegetative growth parameters were poor indicators of peanut injury from ethalfluralin. Without confounding factors such as poor seed quality or cool temperatures at planting, peanut treated with excessive rates of ethalfluralin will usually emerge on time, have an adequate stand, and otherwise have seemingly normal vegetative growth. The facets of peanut growth most commonly affected by ethalfluralin injury were pod biomass and yield. Excessive rates of ethalfluralin inhibited pod biomass and ultimately reduced yield. The inhibition of pod biomass and related symptoms are in general agreement with previous symp-

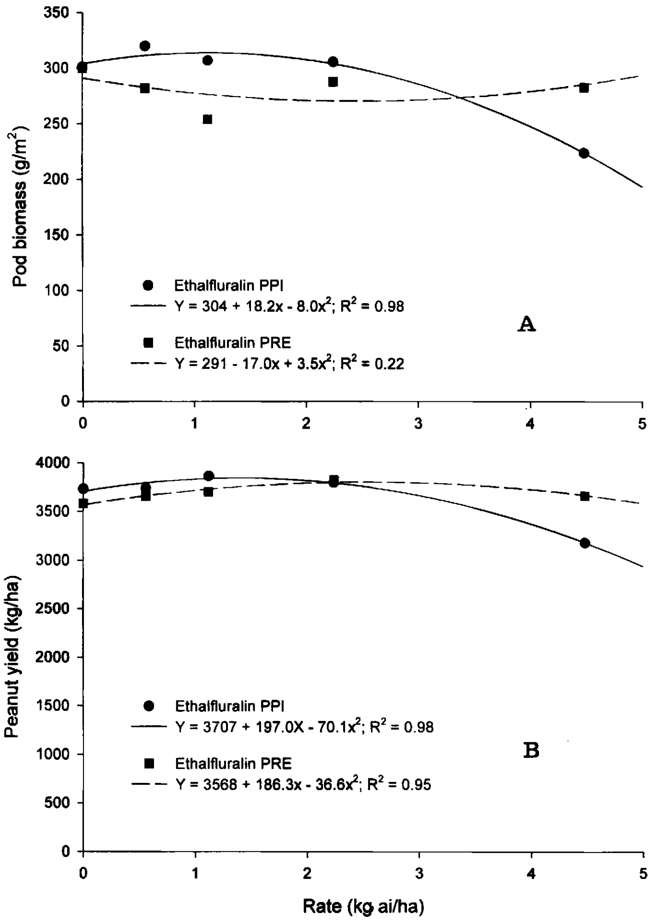

Fig. 2. Effect of ethalfluralin on reproductive growth at Headland, AL; Gainesville, FL; and Tifton, GA, 1994 and 1995. A = pod biomass; B = yield.

tom descriptions of other dinitroaniline herbicides (Merkle, 1975).

Second, ethalfluralin can be safely applied PRE to peanut at 0.6 to 1.1 kg/ha and activated with either irrigation or rainfall without affecting time of emergence, stand, canopy width, foliage biomass, pod biomass, and yield. Furthermore, at elevated rates, ethalfluralin is less injurious to peanut applied PRE compared with PPI. Amending the ethalfluralin registration to include PRE applications at 0.6 to 1.1 kg/ha will not increase the likelihood of peanut injury.

Third, these data suggest that ethalfluralin can be safely used on peanut, applied either PPI or PRE, at registered rates without injury. The rates evaluated where consistent significant effects on vegetative growth, pod formation, and yield occurred were greater than four times the registered rate on soils present in the southeastern Coastal Plain. At registered rates, ethalfluralin did not injure peanut or reduce yields.

These data show the safety of ethalfluralin applied PRE on peanut. Other studies have shown ethalfluralin applied PRE and activated with irrigation to be equally efficacious on Texas panicum (*Panicum texanum* Buck.) and southern crabgrass [*Digitaria ciliaris* (Retz.) Koel.] along with certain small-seeded dicot weeds as ethalfluralin applied PPI (W. C. Johnson, III, unpub. data, 1997). Activating ethalfluralin applied PRE with center-pivot irrigation is more economical than using mechanical incorporation for PPI applications (C. C. Dowler, pers. commun., 1997). Furthermore, a rapidly emerging and uniform peanut stand insured by using irrigation immediately after planting is agronomically advantageous to peanut growers. Amending the ethalfluralin registration to include PRE applications activated with irrigation will give peanut farmers greater flexibility in managing weeds.

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