Peanut Yield Response to Dicamba

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ABSTRACT

Research was conducted at eight locations across the United States peanut belt during 2008 to evaluate peanut response to postemergence applications of dicamba. Dicamba was applied at 0, 40, 70, 140, 280 and 560 g ai/ha at 30, 60, and 90 days after peanut planting (DAP). In 5 of 8 locations, peanut yield losses were greater when dicamba was applied at 30 and 60 DAP when compared to 90 DAP. Estimated yield losses for dicamba applied at 40 g ai/ha ranged between 2% to 29%. Estimated yield losses for dicamba applied at 560 g ai/ha ranged between 23% to 100%. These data may aid peanut growers in making appropriate management decisions in situations where off-target movement of dicamba has occurred or sprayer contamination is suspected.

Key Words: *Arachis hypogaea* L., crop tolerance, drift, herbicide injury, sprayer contamination.

Concerns regarding glyphosate-resistant weeds has led to an interest in developing alternative herbicide-tolerant crops. Dicamba-tolerance is being developed in several broadleaf crops including soybean [*Glycine max* (L.) Merr.] and cotton (*Gossypium hirsutum* L.) (Behrens *et al.* 2007; Subramanian *et al.* 1997). Currently, dicamba is registered for postemergence broadleaf weed control use in various grass crops such as field corn (*Zea mays* L.), sorghum [*Sorghum bicolor* (L.) Moench], and wheat (T*riticum aestivum* L.) (Anonymous, 2011).

Dicamba's reputation for off -target movement due to drift and volatility has been well documented (Al-Khatib and Peterson, 1999; Behrens and Lueschen, 1979). In the southeast, peanut is grown in close proximity to both soybean and cotton. Thus, the adoption of dicamba-tolerance in these crops increases the probability of drift, volatilization, and tank contamination problems that could negatively influence peanut development and yield.

Peanut response to dicamba has not been well documented. Dicamba applied at approximately 2 g/ha had no effect on peanut yield in one field trial (Prostko *et al.* 2009). However, other studies on the control of volunteer peanut indicated that peanut is not tolerant of dicamba (York *et al.* 1994). In a related forage crop, rhizome peanut (*Arachis glabrata* Benth) yields were significantly reduced by a foliar application of dicamba + 2,4-D (Ferrell *et al.* 2006). Other systematic studies on the influence of dicamba rate and timing on peanut have not been published in the literature. Therefore, the objective of this research was to quantify the effects of various rates of dicamba, applied at 30, 60 or 90 days after planting (DAP), on peanut yield.

Materials and Methods

Field trials were conducted at eight locations across the United States peanut belt during 2008. A complete description of these locations is presented in Table 1. Production and pest management practices were followed according to local Cooperative Extension recommendations.

All trials were conducted in a randomized complete block design with a three (application timing) by six (dicamba rate) factorial arrangement of treatments. Dicamba timings were 30, 60, and 90 DAP and dicamba rates were 0, 40, 70, 140, 280, 560 g ai/ha. The typical use rate of dicamba in grass crops is 280 g ai/ha. All treatments were replicated four times. Dicamba was applied using a CO_2-pressurized sprayer calibrated to deliver 94–140 L/ha. All plot areas were maintained weed-free throughout the season using a combination of herbicides (pendimethalin, diclosulam, flumioxazin, imazapic, 2,4-DB) and hand-weeding. Peanut yield data were obtained by mechanical harvesting at maturity.

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Table 1. Locations, varieties, planting dates, harvest dates, and soil types for the peanut/dicamba tolerance studies in 2008.

Location	Peanut Variety	Planting Date	Digging Date	Harvest Date	Soil Characteristics OM (%)	Sand (%)	Silt (%)	Clay (%)
Citra, FL	Georgia Green	23 April	25 Aug.	28 Aug.	0.5	97	1	2
Jay, FL	Florida-07	12 May	14 Sept.	18 Sept.	2.1	69	16	15
Ty Ty , GA	AP-3	12 May	26 Sept.	29 Sept.	1.07	94	2	4
Plains, GA	Georgia-02C	13 May	3 Oct.	7 Oct.	1.0	40	25	34
Rocky Mount, NC	VA-98R	20 May	8 Oct.	14 Oct.	1.1	61	11	28
Florence, SC	Champs	19 May	8 Oct.	15 Oct.	2.3	83	10	7
Lamesa, TX	Flavor Runner 458	30 Apr.	27 Oct.	5 Nov.	0.4	67	14	19
Yoakum, TX	Tamrun OL02	16 June	3 Nov.	5 Nov.	1.0	70	16	14

The data were analyzed as a split-plot. Location was the main plot with herbicide rate and days after planting randomized within each location.

Dependent variables were transformed to percent of control then subtracted from 100 to represent percent loss. PROC GLM (SAS, 2008) was used to analyze the full model. When there were significant interactions between location and rate or location and timing, rate and timing were analyzed within each location. Regression models were developed by regressing percent yield loss over herbicide rate. Linear models were fit using SigmaPlot[1] and the results are summarized in Figures 1–4.

Results and Discussion

Significant interactions between location and dicamba timing prevented pooling of data (P = 0.0001). Therefore, data is presented by individual location. ANOVA tables by locations are presented in Table 2.

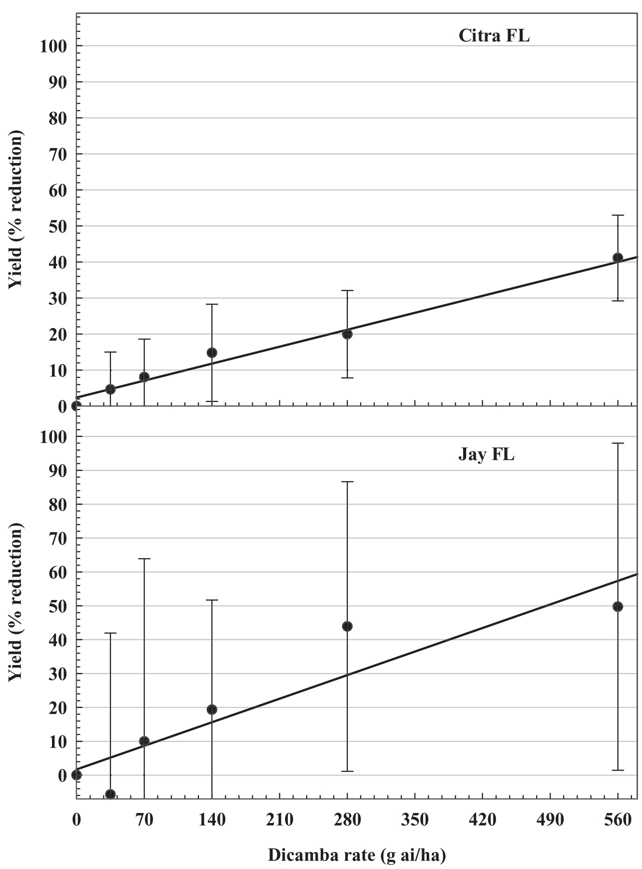

Fig. 1. The influence of dicamba rate on peanut yield loss averaged over 3 application timings (30, 60, and 90 DAP) in Florida. Citra, $y = 0.07x + 2.37$, $R^2 = 0.61$; Jay, $y = 0.10x + 1.72$, $R^2 = 0.18$.

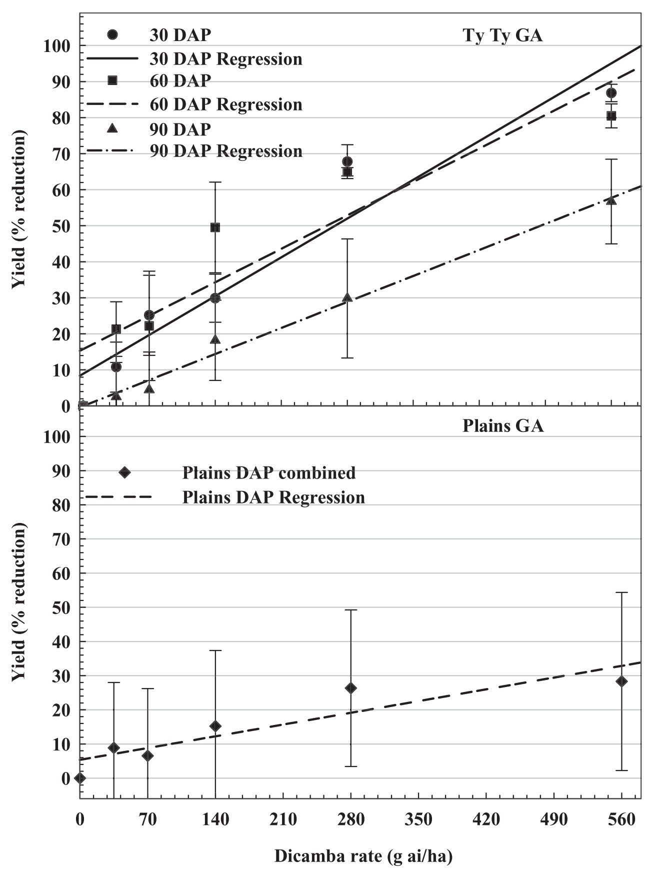

Fig. 2. The influence of dicamba rate on peanut yield loss in Georgia. Ty Ty, 30 DAP, $y = 0.15x + 8.93$, $R^2 = 0.89$; 60 DAP, $y = 0.13x + 15.78$, $R^2 = 0.78$; 90 DAP, $y = 0.10x - 0.03$, $R^2 = 0.80$; Plains (averaged over 3 application timings), $y = 0.05x + 5.37$, $R^2 = 0.18$.

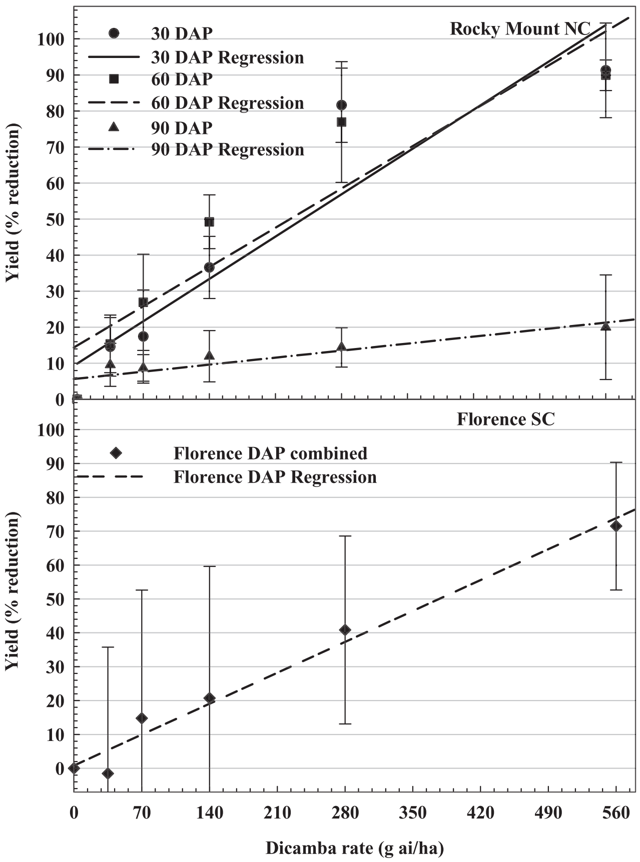

Fig. 3. The influence of dicamba rate on peanut yield loss in North and South Carolina. Rocky Mount, 30 DAP, $y = 0.17x + 9.91$, $R^2 = 0.82$; 60 DAP, $0.16x + 14.92$, $R^2 = 0.80$; 90 DAP, $0.03x + 5.74$, $R^2 = 0.36$; Florence (averaged over 3 application timings), $y = 0.13x + 0.76$, $R^2 = 0.43$.

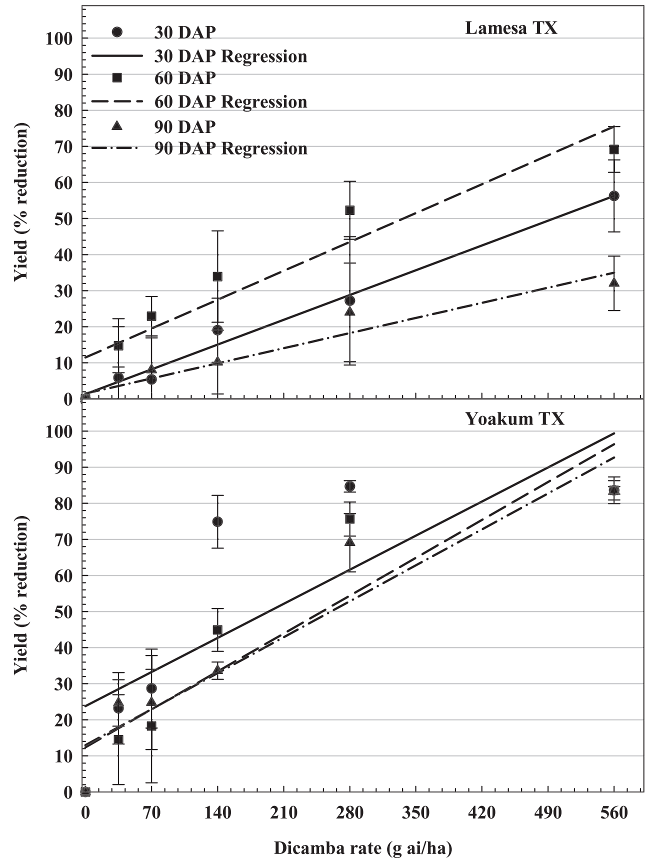

Fig. 4. The influence of dicamba rate on peanut yield loss in Texas. Lamesa, 30 DAP, $y = 0.10x + 1.33$, $R^2 = 0.75$; 60 DAP, $y = 0.11x + 11.50$, $R^2 = 0.84$; 90 DAP, $y = 0.06x + 1.50$, $R^2 = 0.67$; Yoakum, 30 DAP, $y = 0.14x + 23.79$, $R^2 = 0.61$; 60 DAP, $0.15x + 12.36$, $R^2 = 0.79$; 90 DAP, $0.14x + 12.97$, $R^2 = 0.85$.

At Citra, Jay, Plains, and Florence, there were no interactions between dicamba rate and timing. At these locations, there was a weak linear relationship (R^2 range from 0.18–0.61) between dicamba rate and peanut yield loss when pooled over application timing (Figures 1, 2, and 3). Generally, as dicamba rate increased, peanut yield decreased. Estimated peanut yield losses from the lowest rate of dicamba (40 g/ha) were 5%, 6%, 7%, 6% at Citra, Jay, Plains, and Florence, respectively. Estimated peanut yield losses from the highest rate of dicamba (560 g/ha) were 42%, 58%, 33%, 74%, at Citra, Jay, Plains, and Florence, respectively.

At the Citra location, dicamba timing had no effect on peanut yield loss (Table 3). At Jay, applications of dicamba at 30 DAP caused greater yield losses than when applied at 60 or 90 DAP. In Plains, dicamba applied at 60 and 90 DAP resulted in greater yield losses than when applied at 30 DAP. In Florence, dicamba applied at 30 and 60 DAP, resulted in greater yield losses than when applied at 90 DAP.

At Ty Ty, Rocky Mount, Lamesa, and Yoakum, there were significant interactions between dicamba rate and time of application (Figures 2, 3, and 4). At these locations, there was a stronger linear relationship between dicamba rate and yield loss (R^2 range from 0.36–0.89). Generally, peanut yield losses were greater when dicamba was applied at 30 and 60 DAP when compared to 90 DAP. Peanut may be more tolerant of dicamba at 90 DAP for several reasons. First, significant vine density at this time may impede spray coverage. Second, approximate stages of peanut growth were R1 (beginning bloom), R3 (beginning pod) and R6 (full seed) at 30, 60, and 90 DAP, respectively. In soybean, dicamba caused greater yield reductions when exposure occurred at bloom (Auch and Arnold, 1978; Wax *et al*., 1969; Weidenhamer *et al.*, 1989). Similar results have also been observed in cotton (Hamilton and Arle 1979). Estimated yield losses from the lowest rate of dicamba (40 g/ha) were 2% to 29%, 16% to 21%, and 4% to 19% for 30, 60, and 90 DAP, respectively. Estimated yield losses from the highest rate of dicamba (560 g/ha) were 57% to 100%, 73% to 100%, and 23% to 91% for 30, 60, and 90 DAP, respectively.

Table 2. Analysis of variance for dicamba effects on peanut pod yield loss in Florida, Georgia, North Carolina, South Carolina, and Texas.

Location	Effect	Numerator DF	Denominator DF	F value	Pr > R	
Citra, FL	Timing (T)	2	70	2.5	0.0914	NS[a]
	Rate (R)	5	70	30	<0.0001	***
	T * R	10	70	1.3	0.2711	NS
Jay, FL	T	2	70	7.4	0.0016	***
	R	5	70	4.5	0.0018	***
	T * R	10	70	0.7	0.6925	NS
Ty Ty, GA	T	2	71	48	<0.0001	***
	R	5	71	146	<0.0001	***
	T * R	10	71	4.7	0.0001	***
Plains, GA	T	2	69	5.9	0.0016	***
	R	5	69	4.6	0.0050	***
	T * R	10	69	1.6	0.1320	NS
Rocky Mount, NC	T	2	71	93	<0.0001	***
	R	5	71	100	<0.0001	***
	T * R	10	71	16	<0.0001	***
Florence, SC	T	2	71	17	<0.0001	***
	R	5	71	19	<0.0001	***
	T * R	10	71	1.2	0.3048	NS
Lamesa, TX	T	2	63	25	<0.0001	***
	R	5	63	63	<0.0001	***
	T * R	10	63	2.8	0.0087	***
Yoakum, TX	T	2	67	22	<0.0001	***
	R	5	67	371	<0.0001	***
	T * R	10	67	8.8	<0.0001	***

[a]Abbreviation: NS, not significant; *, **, and *** = levels of probability at $P \leq 0.05$, 0.01, and 0.001, respectively.

The original intent of this research was to develop a single model that could be used across the U.S. peanut belt to accurately estimate the potential negative yield effects of off-target movement or sprayer contamination of dicamba. Unfortunately, the variability in peanut response between locations was greater than anticipated. It is reasonable to assume that the differences in peanut yield loss caused by dicamba rate and timing between locations was related to variety, soil type, and environmental conditions. Regardless of the specific results at these locations, it is evident that peanut is not tolerant of dicamba. Additionally, these results further justify the continued need for state specific weed science research.

Table 3. Peanut yield loss as influenced by dicamba timing at four locations (Citra, Jay, Plains, Florence).[ab]

Timing	Location			
	Citra	Jay	Plains	Florence
-DAP[c] -	%			
30	17 a	43 a	4 b	29 a
60	16 a	5 b	16 a	40 a
90	11 a	11 b	21 a	4 b

[a]All data were averaged over six dicamba rates.
[b]Means in the same column with the same letter are not significantly different according to pairwise t-tests (alpha = 0.05).
[c]DAP = days after planting.

Summary and Conclusions

Significant peanut yield losses from dicamba were observed at rates as low as 40 g/ha (0.14× normal use rate). Yield losses from this rate ranged between 2% to 29%. Generally, peanut plants were more sensitive to dicamba at 30 and 60 DAP. If the use of dicamba-tolerant cotton and soybean becomes widely adopted in the future, peanut growers must avoid dicamba drift and sprayer contamination, particularly during the early reproductive stages of growth.

Sources of Materials

[1]SigmaPlot, Version 11, Systat Software Inc., 1735 Technology Drive, Suite 430, San Jose, CA 95110.

Acknowledgments

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