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National Peanut Board
Final Report for 2015 Funding Cycle

I. Identification
a. Project Title:

Growth and yield performance of breeding lines with contrasting postemergence herbicide tolerance levels

b. Funding Year: 2015

c. Principal Investigator(s):
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d. Cooperating Personnel:
Barry Tillman, Ph.D., Peanut Breeder, University of Florida, North Florida Research, Education Center, 3925 Highway 71, Marianna, FL 32446. Tel. 850-394-9124, E-mail: btillman@ufl.edue. Total Funds Requested: $ 17,793.00

f. Location(s) where research will be performed: West Florida Research and Education Center, Jay, FL.

g. New or Continuing Project: New Project

Hypothesis and Objectives:

Our hypothesis is that differences in HT between peanut breeding lines are strongly genetically controlled and can affect peanut growth and yield under field conditions depending on herbicide rate.

The main objective is to characterize the level of postemergence (POST) HT of selected peanut breeding lines and commercial varieties under field conditions.

Specific Research Objectives:
1. Characterize the tolerance of selected breeding lines to contact POST herbicides under field conditions.
2. Characterize the tolerance of selected breeding lines to auxinic herbicides under field conditions.

Generate F_1 and F_2 progenies from crosses between PI-371521 (highly susceptible) PI-152146 (highly tolerant)

Experimental Plan and Methods

The studies were conducted at the West Florida Research and Education Center in Jay, FL.

PI-371521 (highly susceptible), PI-152146 (highly tolerant) and Florida-07 and Georgia-06G (commercial standards) were grown under field conditions, and were treated at the 3- to 6-leaf (V3 to V6) and pegging (R2) stages with 82 and 160 g ai ha^{-1} of glufosinate (contact herbicide), and 70 and 140 g ai ha^{-1} of dicamba (auxinic herbicide). These rates allowed identifying differences in injury between lines without causing plant death, making possible to determine yield. A non-treated control was included for each line. Injury ratings visually estimated were assessed at 14 days after treatment (DAT). At maturity, plants were harvested, and plant dry weight and yield were determined.

The study was arranged as a split-plot design with 4 replications being herbicide treatment the main plot and peanut line the subplot. Each experimental unit consisted of a single plant. Plants were spaced at 1.8 m.

Data were analyzed using Analysis of Variance to determine the significance of the main effects herbicide, rate, genotype, and their interactions. Fisher's Protected Least Significant Difference ($\alpha = 0.1$) was used for mean separation.

Additionally, in order to develop the necessary tools to study the heritability of the HT trait, 8 reciprocal crosses of PI-371521 (highly susceptible) × PI-152146 (highly tolerant) were done under greenhouse conditions.

Results

Greenhouse crosses

Crosses between PI-371521 (highly susceptible) × PI-152146 (highly tolerant) were conducted, but only two were successful. One pod from each cross was successfully produced and stored. F1 pods will be used to produce a F2 progeny in 2016.

Field experiment

All herbicide treatments reduced plant dry weight (DW) and yield reduction >70% (Table 1). Herbicide application timing influenced DW and yield reduction. Analyzed across cultivars, glufosinate and dicamba reduced DW and yield more when applied at the 3- to 6-leaf stage than at pegging, and this was more evident for glufosinate (Table 1).

Table 1. Peanut plant dry weight and pot yield after treatment with dicamba and glufosinate at the 3- to 6-leaf stage and at pegging, in Jay, FL.[a]

Herbicide	Rate g ai/ha	Timing	Plant Dry Weight g		Pod yield g/plant	
Nontreated			48.22	a[b]	19.62	a
Dicamba	70	3-6 leaf	6.67	cd	2.61	bc
		At-pegging	13.02	b	4.16	b
	140	3-6 leaf	2.21	ef	0.47	ef
		At-pegging	2.77	ef	0.88	de
Glufosinate	82	3-6 leaf	9.20	bc	1.73	cd
		At-pegging	12.04	b	3.78	b
	160	3-6 leaf	0.57	f	0.04	f
		At-pegging	3.83	de	1.00	de

[a] Data were pooled across 4 peanut cultivars.

[b] Values with the same letter within columns are not statistically different based on Fisher's Protected LSD.

There were significant interactions between cultivar and herbicide treatments ($P<0.05$) for DW and yield reductions confirming that the evaluated cultivars differed in herbicide tolerance as previously observed under greenhouse conditions.

Table 2. Plant dry weight and pot yield of four peanut cultivars after treatment with dicamba and glufosinate at the 3- to 6-leaf stage, in Jay, FL.[a]

Cultivar	Herbicide	Rate	Plant Dry Weight		Pod yield	
		g ai/ha	g		g/plant	
PI-152146	Nontreated		59.1	a[a]	15.3	bc
	Glufosinate	82	13.8	d-g	2.8	e-j
		160	1.0	mn	0.2	kl
	Dicamba	70	5.7	g-m	1.8	f-k
		140	1.4	lmn	0.0	l
PI-371521	Nontreated		60.4	a	9.1	bcd
	Glufosinate	82	18.8	cde	2.1	e-j
		160	0.0	n	0.0	l
	Dicamba	70	11.4	d-i	3.9	d-g
		140	2.7	i-n	0.7	i-l
Florida-07	Nontreated		46.5	ab	42.6	a
	Glufosinate	82	6.7	f-m	2.1	f-j
		160	0.0	n	0.0	l
	Dicamba	70	5.6	g-m	3.0	e-i
		140	1.4	lmn	0.6	i-l
Georgia-06G	Nontreated		30.2	bc	24.1	ab
	Glufosinate	82	2.1	j-n	0.5	jkl
		160	1.7	k-n	0.0	l
	Dicamba	70	4.8	g-n	2.1	e-j
		140	3.6	h-n	0.8	h-l

[a] Values with the same letter within columns are not statistically different based on Fisher's Protected LSD.

When the plants were treated at the 3- to 6-leaf stage, the four cultivars responded similarly to herbicide treatments. The most severe DW and yield reductions were observed for the highest rates of glufosinate and dicamba (Table 2). It is worth noting that PI-152146 was the only cultivar that produced pods after treatment with the high rate of glufosinate.

Table 3. Plant dry weight and pot yield of four peanut cultivars after treatment with dicamba and glufosinate at the pegging stage, in Jay, FL.[a]

Cultivar	Herbicide	Rate	Plant Dry Weight		Pod yield	
		g ai/ha	g		g/plant	
PI-152146	Nontreated		59.1	a[a]	15.3	bc
	Glufosinate	82	25.2	cd	6.8	cde
		160	1.7	k-n	0.7	i-l
	Dicamba	70	17.4	c-f	6.9	cde
		140	1.2	lmn	0.2	kl
PI-371521	Nontreated		60.4	a	9.1	bcd
	Glufosinate	82	9.2	e-k	1.1	g-l
		160	6.6	f-m	1.0	g-l
	Dicamba	70	11.7	d-h	1.6	f-k
		140	0.0	n	0.0	l
Florida-07	Nontreated		46.5	ab	42.6	a
	Glufosinate	82	5.8	g-m	3.9	d-g
		160	2.5	j-n	0.5	jkl
	Dicamba	70	10.0	e-j	3.3	d-h
		140	4.5	g-n	1.0	g-l
Georgia-06G	Nontreated		30.2	bc	24.1	ab
	Glufosinate	82	11.5	d-h	5.6	c-f
		160	5.5	g-m	2.0	f-j
	Dicamba	70	13.5	d-g	6.9	cde
		140	8.3	e-l	4.5	def

[a] Values with the same letter within columns are not statistically different based on Fisher's Protected LSD.

After treatment at-pegging, PI-152146 was the cultivar that suffered the lowest DW and yield reductions based on the nontreated control (Table 3). For example, with the low rate of glufosinate, PI-152146 protected 43 and 44% while PI-371521 only 15 and 12% of the DW and yield, respectively, based on their respective nontreated controls. As determined previously in the greenhouse, Florida-07 and Georgia-06G exhibited intermediate phenotypes that tend to overlap more frequently with PI-152146 than PI-371521. Also, at the low rate of dicamba, PI-152146 exhibited the lowest yield loss 55%, which was considerably lower than the yield losses suffered by the other cultivars (82, 92, and 72% for PI-371521, Florida-07, and Georgia-06G, respectively). At the high rates of glufosinate and dicamba all cultivars suffered >90% DW and yield loss, with the exception of Georgia-06G. However, this could be the result of a lower DW and yield in the nontreated control of Georgia-06G (Table 3).

Conclusions and Practical Implications

The results of the present study confirmed that the germplasm previously identified as highly tolerant and highly susceptible to postemergence herbicides under greenhouse conditions, exhibit similar phenotypes under field conditions. However, growth stage at herbicide application timing plays a major role on the effect of the herbicide on DW and yield. Therefore, herbicide tolerance screening should be done when the herbicide is more likely going to be used under field conditions for effective weed control.

Although the highly tolerant cultivar PI-152146 was more tolerant than commercial cultivars Florida-07 and Georgia-06G, especially at the low rates, the tolerance levels were not always statistically different between these cultivars. This underscores the importance of using breeding strategies, and not only selection approaches to increase herbicide tolerance.

The fact that the differences in herbicide tolerance for PI-152146 and PI-371521 exist for both glufosinate (a contact glutamine synthase inhibiting herbicide) and dicamba (a systemic auxinic herbicide) suggests that the tolerance mechanism(s) might be non-target and could potentially provide tolerance to herbicides with other mechanisms of action.