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National Peanut Board

Final Report for 2014 Funding Cycle

I. Identification

a. Project Title:

Characterization of selected peanut breeding lines for postemergence herbicide tolerance level

b. Funding Year: 2014

c. Principal Investigator(s):

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e. Total Funds Requested: $ 15,000.00

f. Location(s) where research will be performed:

West Florida Research and Education Center, Jay, FL.

g. New or Continuing Project: Continuing Project

Hypothesis and Objectives:

The central hypothesis of this study is that differences in herbicide tolerance between peanut breeding lines can be used to develop commercial cultivars with improved herbicide tolerance. However, proper screening procedures are necessary to distinguish between tolerant and susceptible lines.

The main objective is to characterize the level of postemergence (POST) herbicide tolerance of selected breeding lines of the University of Florida Peanut Mini-Core collection.

Specific Research Objectives:

1. Characterize the tolerance of selected breeding lines to contact POST herbicides.
2. Characterize the tolerance of selected breeding lines to auxinic herbicides.
3. Identify a rate for each POST herbicide that allows practical distinction between susceptible and tolerant lines.

Report

During the summer and fall 2014, greenhouse studies were conducted to evaluate the tolerance of peanut breeding lines PI-152146, PI-356004, PI-371521, and PI-372271 and commercial cultivars Florida-07 and Georgia-06G to several postemergence herbicides. The experiments were dose-response studies using 5 different rates of 2,4-D amine, dicamba, glufosinate, paraquat, and flumioxazin. Peanut injury and dry weight reductions were determined.

The response of the peanut lines to increasing rates differed depending on the herbicide used. Therefore, results were analyzed using linear, exponential rise to a maximum (two parameters) and rectangular hyperbola (two parameters) models for injury (Table 1) and linear and exponential decay models (two and three parameters, respectively) for dry weight (DW) (Table 2). PI-152146 exhibited one of the lowest rates of change (parameter *m*) in injury (Table 1) and DW (Table 2) in response to increasing rates of all herbicides. Conversely, PI-371521 had the greatest response rate for injury and dry weight reduction (DWR) for all herbicides, except dicamba. PI-356004 and PI-372271 were the lines that suffered more injury and lost more DW when dicamba rate increased (Tables 1 and 2). Florida-07 and Georgia-06G were consistently more tolerant than was PI-371521 for all herbicides, but they were not as tolerant as PI-152146 in all cases.

The rates causing 50% injury (I_{50}) and 50% reduction in growth (GR_{50}) were consistent in the ranking of tolerance among the different lines (Table 3). For 2,4-D, the most tolerant lines were the commercial standards and PI-152146, for which GR_{50} values could not be estimated because their tolerance level was high enough that the rate of DWR was not different than zero in the range of rates evaluated (Table 2). Therefore, we concluded that the GR_{50} was a least 2,128 g ha^{-1}, the highest rate evaluated. These lines had I_{50} values between 1 and 2.5 times greater and GR_{50} values at least 2.3 times greater than the most susceptible line, PI-371521. PI-3560004, and PI-372271 exhibited intermediate tolerance.

I_{50} values were 0.4 to 1.5 times greater, and GR_{50} values were 1.3 to 13 times greater for PI-152146 and Georgia-06G than they were for PI-356004, PI-371521, and PI-372271 (Table 3). Similar to 2,4-D, PI-152146–dicamba GR_{50} values were outside the rate range evaluated, so dicamba GR_{50} was considered at least 560 g ha^{-1}.

For glufosinate, paraquat, and flumioxazin, Florida-07, Georgia-06G, and PI-152146 were the most tolerant lines, with I_{50} and GR_{50} values that were approximately one to two times greater than those for PI-371521, the most susceptible line (Table 3). The remainder of the lines exhibited intermediate tolerance levels.

In the case of dicamba, PI-152146 GR_{50} was at least 2.8 and 4.7 times greater than for Florida-07 and Georgia-06G (Table 3). This suggests that there is genetic variability among peanut lines that could be used to increase dicamba tolerance compared with existing commercial cultivars.

Conclusions and Practical Implications

The present study indicated that differences in I_{50} and GR_{50} values frequently ranging from 0.4 to 2.5, but in some instances up to 13 fold when comparing the most tolerant to the most susceptible lines, confirmed that ignoring herbicide tolerance until final stages of the breeding/selection process could significantly affect the success of cultivar development. In addition the commercial standards consistently performed similarly to the most herbicide tolerant lines. This has implications for cultivar development because if most of the new breeding lines have low herbicide tolerance levels, crossing elite lines with these new breeding lines is likely to reduce herbicide tolerance. If the breeder is aware of this risk, simple selection strategies such as backcrosses to the elite line complemented with herbicide tolerance tests could be implemented to make sure that the herbicide tolerance is maintained at acceptable levels.

Although the mechanisms of tolerance for the studied peanut lines are not known, because PI-152146, Florida-07 and Georgia-06G were consistently tolerant and PI-371521 was consistently susceptible to herbicides with different MOA, it is more likely that non-target site mechanisms such as herbicide absorption, translocation, and/or metabolism are responsible for the tolerance rather than target site mutations.

Based on these results, peanut-breeding programs would benefit from screening breeding lines for tolerance to key herbicides and develop an herbicide tolerance catalogue. This would allow for properly designing screening and selection strategies to account for possible reductions in herbicide tolerance or take specific steps towards augmenting the maximum herbicide tolerance of future commercial cultivars; thus, allowing the use of higher herbicide rates or reducing the risk of injury when peanut is growing under stressful conditions. For example, if PI-371521, which was the most susceptible line in the present study, must be crossed with an elite cultivar to introduce a desirable trait (e.g. white mold resistance or oil content), being aware of the low herbicide tolerance this line has enables the breeder to take specific actions to mitigate this problem. The breeder could include herbicide tolerance screenings or even conduct crosses with highly herbicide tolerant lines (e.g. PI-152146) to make sure that the cultivar will perform properly when grown under commercial herbicide programs.

Products

The results of the present project were presented in two field days covering more than 100 growers and several professional meetings. Additionally, a refereed scientific article was published in the journal Weed Science. See details below:

Refereed article:

Leon RG, Tillman BL (2015) Postemergence herbicide tolerance variation in peanut germplasm. Weed Science. *In press*

Abstracts:

Leon RG, Tillman BL (2015) Intra-specific variation for postemergence herbicide tolerance in peanut. Weed Sci Soc Am Abstr 55:189

Leon RG, Tillman BL (2015) Identification of peanut breeding lines with high and low tolerance to postemergence herbicides. Proc South Weed Sci Soc 68:252

Leon RG, Tillman B (2014) Characterizing variability in postemergence herbicide tolerance in peanut breeding lines. Proc Am Peanut Res Educ Soc 46:53

Leon RG, Tillman B, Unruh JB, Kenworthy KE (2014) Screening for herbicide tolerance as part of breeding programs to develop more robust weed control strategies. Proc Florida Weed Sci Soc 36:19

Table 1. Parameters of regression analysis describing the dose-response (% injury) of four breeding lines (PI) and two commercial cultivars (Florida-07 and Georgia-06G) of peanut to herbicides.

Herbicide	Model[a]	Cultivar	m			P-value (m)	b			P-value (b)
2,4-D Amine	y=b*(1-exp(-m*x))	PI-152146	1.60E-03	±	4E-04[b]	0.0002	58.7	±	5.3	<0.0001
		PI-356004	2.00E-03	±	5E-04	0.0002	56.8	±	4.7	<0.0001
		PI-371521	3.80E-03	±	8E-04	<0.0001	68.6	±	3.8	<0.0001
		PI-372271	2.90E-03	±	6E-04	<0.0001	65.1	±	3.9	<0.0001
		Florida-07	2.40E-03	±	4E-04	<0.0001	60.7	±	3.6	<0.0001
		Georgia-06G	1.90E-03	±	4E-04	<0.0001	61.7	±	4.6	<0.0001
Dicamba	y=b*x/(m+x)	PI-152146	94.1	±	17.2	<0.0001	72.0	±	4.0	<0.0001
		PI-356004	24.5	±	11.7	0.0476	62.2	±	4.2	<0.0001
		PI-371521	48.4	±	11.7	0.0003	75.2	±	3.9	<0.0001
		PI-372271	43.4	±	10.6	0.0004	75.1	±	3.7	<0.0001
		Florida-07	58.0	±	14.1	0.0004	79.5	±	4.6	<0.0001
		Georgia-06G	58.2	±	15.5	0.0010	71.3	±	4.6	<0.0001
Glufosinate	y = mx + b	PI-152146	0.205	±	0.041	<0.0001	10.8	±	4.3	0.0196
		PI-356004	0.295	±	0.042	<0.0001	6.6	±	4.5	0.1568
		PI-371521	0.365	±	0.039	<0.0001	15.7	±	4.1	0.0008
		PI-372271	0.317	±	0.042	<0.0001	10.5	±	4.5	0.0275
		Florida-07	0.266	±	0.028	<0.0001	6.8	±	3.0	0.0304
		Georgia-06G	0.218	±	0.025	<0.0001	7.0	±	2.7	0.0157
Paraquat	y = mx + b	PI-152146	0.085	±	0.009	<0.0001	6.6	±	3.3	0.0580
		PI-356004	0.094	±	0.011	<0.0001	6.2	±	4.1	0.1405
		PI-371521	0.102	±	0.011	<0.0001	16.4	±	3.9	0.0003
		PI-372271	0.100	±	0.012	<0.0001	19.9	±	4.3	<0.0001
		Florida-07	0.077	±	0.007	<0.0001	8.4	±	2.6	0.0034
		Georgia-06G	0.068	±	0.008	<0.0001	10.5	±	2.8	0.0011
Flumioxazin	y=b*x/(m+x)	PI-152146	24.6	±	4.8	<0.0001	117	±	7	<0.0001
		PI-356004	17.2	±	3.2	<0.0001	112	±	5	<0.0001
		PI-371521	4.8	±	1.4	0.0019	103	±	3	<0.0001
		PI-372271	12.7	±	5.5	0.0296	118	±	11	<0.0001
		Florida-07	11.4	±	2.1	<0.0001	107	±	4	<0.0001
		Georgia-06G	12.7	±	2.1	<0.0001	108	±	4	<0.0001

[a] Simplest regression model that best described the data of all cultivars for each herbicide.
[b] Standard error of the mean (sem).

Table 4. Parameters of regression analysis describing the dose-response (% dry weight based on nontreated) of four breeding lines (PI) and two commercial cultivars (Florida-07 and Georgia-06G) of peanut to POST herbicides.

Herbicide	Model[a]	Cultivar	m	P-value (m)	b	P-value (b)	p	P-value (p)
2,4-D Amine	y=b+p*exp(-m*x)	PI-152146	3.0E-04 ± 9.0E-04[b]	0.7449	22 ± 186	0.9062	84 ± 182	0.6494
		PI-356004	3.4E-03 ± 1.3E-03	0.0124	49 ± 5	<0.0001	52 ± 8	<0.0001
		PI-371521	5.7E-03 ± 2.1E-03	0.0122	49 ± 4	<0.0001	51 ± 6	<0.0001
		PI-372271	8.0E-04 ± 8.0E-04	0.37	25 ± 39	0.5324	72 ± 36	0.0562
		Florida-07	4.0E-04 ± 1.3E-04	0.7422	19 ± 161	0.9085	82 ± 154	0.5977
		Georgia-06G	1.2E-03 ± 8.0E-04	0.1791	50 ± 14	0.001	47 ± 13	0.0016
Dicamba	y=b+p*exp(-m*x)	PI-152146	0.009 ± 0.003	0.0046	52 ± 5	<0.0001	49 ± 7	<0.0001
		PI-356004	0.033 ± 0.015	0.0404	33 ± 4	<0.0001	67 ± 7	<0.0001
		PI-371521	0.019 ± 0.005	0.0005	30 ± 4	<0.0001	69 ± 6	<0.0001
		PI-372271	0.026 ± 0.013	0.0481	32 ± 5	<0.0001	68 ± 10	<0.0001
		Florida-07	0.011 ± 0.006	0.0717	32 ± 8	0.0004	52 ± 11	0.0001
		Georgia-06G	0.020 ± 0.010	0.0483	47 ± 5	<0.0001	53 ± 9	<0.0001
Glufosinate	y=m*x+b	PI-152146	-0.267 ± 0.080	0.0023	110 ± 8	<0.0001		
		PI-356004	-0.377 ± 0.043	<0.0001	98 ± 4	<0.0001		
		PI-371521	-0.458 ± 0.052	<0.0001	99 ± 5	<0.0001		
		PI-372271	-0.300 ± 0.086	0.0016	95 ± 9	<0.0001		
		Florida-07	-0.341 ± 0.097	0.0015	120 ± 10	<0.0001		
		Georgia-06G	-0.264 ± 0.038	<0.0001	106 ± 4	<0.0001		
Paraquat	y=b*exp(-m*x)	PI-152146	1.2E-03 ± 3.E-04	<0.0001	112 ± 6	<0.0001		
		PI-356004	2.2E-03 ± 5.E-04	<0.0001	109 ± 8	<0.0001		
		PI-371521	2.8E-03 ± 4.E-04	<0.0001	106 ± 6	<0.0001		
		PI-372271	2.9E-03 ± 1.E-03	0.0059	102 ± 12	<0.0001		
		Florida-07	1.0E-03 ± 3.E-04	0.0006	110 ± 7	<0.0001		
		Georgia-06G	1.2E-03 ± 2.E-04	<0.0001	109 ± 5	<0.0001		
Flumioxazin	y=b+p*exp(-m*x)	PI-152146	0.030 ± 0.005	<0.0001	-1.14 ± 5.4	<0.0001	103 ± 7	<0.0001
		PI-356004	0.053 ± 0.011	<0.0001	6.14 ± 4.9	0.2246	93 ± 8	<0.0001
		PI-371521	0.123 ± 0.028	0.0002	4.68 ± 2.8	0.1052	95 ± 5	<0.0001
		PI-372271	0.052 ± 0.012	0.0002	-0.03 ± 6.1	0.9956	100 ± 10	<0.0001
		Florida-07	0.028 ± 0.011	0.0139	1.31 ± 9.9	0.8952	80 ± 13	<0.0001
		Georgia-06G	0.039 ± 0.005	<0.0001	3.17 ± 3.4	0.3647	95 ± 5	<0.0001

[a] Simplest regression model that best described the data of all cultivars for each herbicide.

[b] Standard error of the mean (sem).

Table 5. Rate required to cause 50% injury (I_{50}) and to reduce dry weight 50% (GR_{50}) four breeding lines (PI) and two commercial cultivars (Florida-07 and Georgia-06G) of peanut for different POST herbicides.

Herbicide	**Cultivar**	**I_{50}**			**GR_{50}**		
		g ai ha^{-1}		se m	g ai ha-^{1}		se m
2,4-D Amine	PI-152146	1195	±	215	>2128	±	
	PI-356004	1063	±	181	1070	±	75
	PI-371521	344	±	57	650	±	40
	PI-372271	505	±	81	1307	±	274
	Florida-07	722	±	94	>2128	±	
	Georgia-06G	874	±	149	>2128	±	
Dicamba	PI-152146	215	±	2	>560	±	
	PI-356004	101	±	3	40	±	10
	PI-371521	96	±	3	65	±	6
	PI-372271	87	±	3	50	±	12
	Florida-07	98	±	4	98	±	13
	Georgia-06G	137	±	3	147	±	21
Glufosinate	PI-152146	192	±	46	225	±	79
	PI-356004	147	±	31	126	±	15
	PI-371521	94	±	14	107	±	12
	PI-372271	125	±	23	151	±	38
	Florida-07	162	±	24	204	±	79
	Georgia-06G	197	±	30	211	±	34
Paraquat	PI-152146	511	±	82	651	±	39
	PI-356004	465	±	86	356	±	29
	PI-371521	328	±	48	270	±	12
	PI-372271	302	±	47	246	±	78
	Florida-07	538	±	68	752	±	120
	Georgia-06G	586	±	86	626	±	25
Flumioxazin	PI-152146	18	±	1.1	23	±	1.1
	PI-356004	14	±	0.9	14	±	0.9
	PI-371521	5	±	0.7	6	±	0.7
	PI-372271	9	±	1.9	13	±	8.7
	Florida-07	10	±	0.7	18	±	0.3
	Georgia-06G	11	±	0.6	18	±	0.6