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NPB Final Report_2007
Submitted by Peter Dotray
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Title:
Peanut Tolerance and Weed Control with Cobra; Cadre and Pursuit: Influence of Carrier Volume and Spray Tip Selection on Herbicide Activity; and Survey of Problem Peanut Fields in the High Plains.

PART ONE. Peanut Tolerance and Weed Control with Cobra.
Cobra (lactofen) was labeled for use postemergence (POST) in peanut in 2005 for control of several annual broadleaf weeds including annual morningglory. Cobra is classified as a diphenyl ether (cell membrane disruptor). In general, herbicides classified as cell membrane disruptors (contact inhibitors) must be applied to small weeds. Peanut tolerance to Cobra is based on the plants ability to metabolize (break down) the herbicide, which often results in some leaf necrosis after application. Basagran (bentazon) has been shown to safen (reduce) peanut injury when applied in tank mixture with Gramoxone Inteon (paraquat). The objective of this research was to examine peanut response to Cobra applied alone and Cobra applied in tank mixture with Basagran at three application timings.

The experiment was designed as a factorial arrangement with four Cobra rates (0, 0.0976, 0.15625, and 0.1953 lbs ai/A, or 0, 6.25, 9.38, and 12.5 oz/A), 3 Basagran rates (0, 0.15625, and 0.3125 lb ai/A, or 0, 5, and 10 oz/A) and three application timings (6-leaf, 2 weeks after 6-leaf, and 4 weeks after 6-leaf). There was no three-way or two way treatment interaction; therefore, main factors may be discussed separately.

Peanut injury following Cobra applications did increase as rate increased, but injury never exceeded 8% during the growing season (Table 1). End of season injury ranged from 2 to 3% and no treatment caused yield or grade reduction compared to the untreated control. Peanut yield ranged from 6580 to 6693 pounds per acre and were not different from the untreated control (6944 pounds per acre). Peanut injury following Basagran application did not increase as rate increased and injury did not exceed 5% during the growing season (Table 2). No yield or grade reduction was observed following any Basagran rate and yield ranged from 6585 to 6737 pounds per acre. When averaged over application timing, no trend towards increased injury for early or later application was observed (Table 3). Peanut injury following applications made 2 weeks after the 6-leaf stage reached 9%, but injury was less than 4% by the end of the season. Peanut yield was reduced when applications were made at 2 weeks after the 6-leaf treatment. These results suggest that Cobra may cause visible peanut injury following application, but no adverse affects on yield or grade should be observed. These results also suggest that Basagran will not safen peanut from visible injury and application timing had no affect on Cobra injury. Time of application may be important for Cobra applications and these data suggest that applications made at the 6-leaf peanut stage will not cause peanut yield reductions.

Table 1. Peanut injury and yield as affected by Cobra Rate at AG-CARES, Lamesa, TX, 2007 [a].

Treatment	Rate	Peanut Injury					Yield	Grade
		Jun 11	Jun 25	Jul 9	Jul 23	Oct 10		
	lb ai/A	----------------- (%)				-----------------------	lb/A	%
Cobra [b] + COC	0 + 1%	0	1	0	0	0	6944	71
Cobra + COC	0.0976 + 1%	2	5	5	3	2	6693	71
Cobra + COC	0.15625 + 1%	2	6	6	4	3	6580	72
Cobra + COC	0.1953 + 1%	3	8	8	5	3	6633	71
$LSD_{(0.10)}$		0.3	0.6	0.8	0.9	0.7	NS	NS

[a]Abbreviations: COC = crop oil concentrate
[b]Cobra at 0.0976 lb ai/A = 6.25 fluid ounces/acre; 0.15625 lb ai/A = 10 fluid ounces/acre; and 0.1953 lb ai/A = 12.5 fluid ounces/acre

Table 2. Peanut injury and yield as affected by Basagran Rate at AG-CARES, Lamesa, TX, 2007.

Treatment	Rate	Peanut Injury					Yield	Grade
		Jun 11	Jun 25	Jul 9	Jul 23	Oct 10		
	lb ai/A	-------------------- (%)				------------------------	lb/A	%
Basagran [a]	0	1	5	4	3	2	6815	71
Basagran	0.15625	1	5	4	3	2	6585	71
Basagran	0.3125	1	5	5	3	2	6737	71
$LSD_{(0.10)}$		NS	NS	0.7	NS	NS	NS	NS

[a]Basagran at 0.15625 lb ai/A = 5 fluid ounces/acre; 0.3125 lb ai/A = 10 fluid ounces/acre

Table 3. Peanut injury and yield as affected by Timing of Cobra with Basagran at AG-CARES, Lamesa, TX, 2007 [a].

Treatment	Timing	Peanut Injury					Yield	Grade
		Jun 11	Jun 25	Jul 9	Jul 23	Oct 10		
		------------------- (%)				----------------------	lb/A	%
6 LF	6 LF	4	6	1	0	0	6765	71
2 WAT	2 WAT		9	8	5	3	6467	72
4 WAT	4 WAT			6	4	2	6905	71
$LSD_{(0.10)}$		0.3	0.6	0.7	0.7	0.6	252	0.6

[a]Abbreviations: 6 LF = 6 leaf; WAT = weeks after treatment

PART TWO. Influence of Carrier Volume and Spray Tip Selection on Herbicide Activity. *(The report below was written in journal format for submission to Weed Technology. Units are in metric because of journal guidelines. No data tables were included in this report for space concerns, but are certainly available and will be submitted to the journal).*

Field studies were conducted during the 2006 and 2007 growing seasons in the south Texas and southern High Plains peanut growing regions to evaluate weed response when using imazapic or imazethapyr with different spray tips and spray volumes commonly used for weed control in various crops including peanut. Spray volumes of 47 to 187 L/ha were compared for weed control on Texas panicum and various broadleaf weeds. Texas panicum control was affected in one year by spray volume. In that year, as spray volume increased, imazapic and imazethapyr efficacy on Texas panicum decreased. This result may be due to increased relative humidity related to above average rainfall in the one year. Spray volume had no effect on Palmer amaranth efficacy. Smellmelon, pitted morningglory, and prickly sida control with imazapic and imazethapyr decreased as spray volume increased; however, spray tip had no effect on weed control.

Imazapic and imazethapyr at 0.07 kg ai/ha was evaluated in four separate small-plot studies during the 2006 to 2007 growing seasons in the south Texas and the southern High Plains of Texas peanut growing regions for weed control with different spray tips and spray volumes. Spray tips evaluated included 110015 flat fan (FF), 110015 Turbo TeeJet (TT), 110015 drift guard (DG), 110015 air induction (AI), 110015 extended range (XR), and 110015 turbo drop (TD). With the spray tip study, spray volume at the southern High Plains location was 93.5L/ha while at the south Texas location, the spray volume was 187 L/ha. A crop oil concentrate was included with all treatments at the rate of 1% v/v.

The spray volume study was also conducted with imazapic or imazethapyr at 0.07 kg ai/ha using a crop oil concentrate at 1% (v/v). Spray volumes evaluated included 47, 71, 94, 117, 140, 164, and 187 L/ha applied with 11001DG and 110015TT spray tips in south Texas and the southern High Plains of Texas, respectively. Herbicides in south Texas were applied with a CO_2 pressurized backpack sprayer while in the southern High Plains herbicides were applied with a tractor-mounted compressed air small plot sprayer. Spray volume was regulated by varying ground speed, such that a change in efficacy with spray volume was not attributed to droplet size. Weed ratings recorded 28 d after treatment are reported based on a scale of 0 (no control) to 100 (complete control). Weed populations for Palmer amaranth at the southern High Plains location in both years were 24 to 30 plants/m^2 while at the south Texas location in 2006, Texas panicum and Palmer amaranth were present at 6 to 8 plants/m^2. In 2007, at the south Texas location, Texas panicum populations were 2 to 3 plants/m^2 while pitted morningglory, smellmelon, and prickly sida populations were 8 to 10 plants/m^2.

Devil's-claw, Palmer amaranth, puncturevine, and silverleaf nightshade were less than 16 cm tall at the southern High Plains location in either year while at the south Texas location, Palmer amaranth, southern crabgrass, and Texas panicum were less than 20 cm tall. Pitted morningglory and smellmelon were less than 15 cm in length.

The experimental design was a randomized complete block with three replications and either a seven (spray volume) or five (spray tip) by two (imazapic or imazethapyr) factorial arrangement of treatments. Data for percentage of weed control were transformed to the arcsine square root prior to analysis; however, non-transformed means are presented because arscine transformation did not affect interpretation of the data. Treatment means were separated using Fisher's Protected LSD at $P \leq 0.10$.

Each plot at south Texas was two rows 7.6 m long spaced 96 cm apart or 4 m wide by 15 m long at the southern High Plains location. Peanut (*Arachis hypogaea* L.) was planted at the south Texas location but the area was fallow at the southern High Plains location. In 2006 at the south Texas location, supplemental irrigation was applied as needed while in 2007 no irrigation was required due to above average rainfall.

Weed control with different spray volumes. For Texas panicum and Palmer amaranth control, there was a spray volume and herbicide by year interaction; therefore, these variables are presented separately. For devil's-claw, silverleaf nightshade, puncturevine, smellmelon, pitted morningglory, and prickly sida, which were present at one location, there was a herbicide by spray volume interaction.

Annual grass control. In 2006, all spray volumes controlled Texas panicum at least 94% (Table 1). Only the spray volume of 47 L/ha provided less control than the 70, 94, 140, or 164 L/ha rate. In 2007, spray volumes of 94 L/ha or less controlled southern crabgrass at least 86% while spray volumes of 117 L/ha or greater controlled southern crabgrass 75% or less. Imazethapyr, nicosulfuron, and sethoxydim with methylated vegetable oil applied on an area basis were equally or more effective when applied in 37 to 75 L/ha than in 94 to 187 L/ha (Kirkwood 1993). Ramsdale and Messersmith (2002) reported that high herbicide concentration increased imazethapyr absorption when sufficient adjuvant was present. Absorption also increased as herbicide concentration increased for glyphosate, sethoxydim, fluazifop-butyl, and haloxyfop-methyl (Buhler and Burnside 1984; Cranmer and Linscott 1990; 1991).

When imazapic was compared with imazethapyr, no difference in Texas panicum or southern crabgrass control with imazapic or imazethapyr was noted in either year (data not shown). In 2006, imazapic and imazethapyr controlled Texas panicum at least 96% while in 2007 both herbicides provided no better than 74% control of southern crabgrass. In a previous study evaluating POST herbicides, imazapic controlled Texas panicum at least 80% when used without a soil-applied herbicide (Grichar et al. 2003). The imidazolinone herbicides usually provide partial control of annual grasses (author's personal observation). Imazethapyr soil-applied will provide virtually no control; however, imazapic applied POST will control Texas panicum 60 to 70% and greater than 90% control of southern crabgrass and broadleaf signalgrass when applied to grasses less than 3 cm tall. The use of a dinitroaniline herbicide with either imazapic or imazethapyr improved Texas panicum control over the dinitroaniline herbicide alone (Grichar et al. 1999).

Palmer Amaranth Control. In 2006, at the southern High Plains location, no spray volume provided better then 65% Palmer amaranth control (Table 1). Spray volumes of 47 or 94 L/ha controlled Palmer amaranth at least 64%; however, spray volumes of 117 to 187 L/ha controlled no better than 50%. At the south Texas location, all spray volumes controlled Palmer amaranth at least 98%. In 2007, the spray volume of 187 L/ha controlled less Palmer amaranth than spray volumes of 47, 70, and 117 L/ha. The improved control of Palmer amaranth at the south Texas location may be due to higher air temperatures and relative humidities during the June to August growing period (data not shown). Typically air temperatures in south Texas during this time period in the daytime range from 32 to 38^0 C while nighttime temperatures seldom fall below 27^0 C. Also, relative humidities usually range from 75 to 90% (authors personal observation). Daytime temperatures in the southern High Plains may be similar but fall to less than 27^0 C during the nighttime while relative humidities rarely get above 40% (authors personal observations). Air temperature and relative humidity directly influence herbicide absorption and translocation in plants (Wanamarta and Penner 1989). In general, the uptake and translocation of most POST herbicides increases with increasing temperature and humidity (Wanamarta and Penner 1989). Relative humidity enhances the absorption and translocation of herbicides in plants by prolonging the drying of the spray droplets on the leaf surface, increasing cuticle hydration, and to a smaller extent by favoring stomatal opening (Hull 1970).

Only in 2006, only at the southern High Plains location was there a difference in Palmer amaranth control between imazapic and imazethapyr. Imazapic controlled Palmer amaranth 59% while imazethapyr provide 48% control. At the south Texas location both herbicides provided at least 99% control while in 2007 at the southern High Plains location both herbicides provided 73 to 75% control (data not shown). In earlier work, imazapic at 0.04 to 0.07 kg/ha controlled Palmer amaranth at least 95% when applied EPOST while imazethapyr provided at least 90% control in 2 of the 3 yr (Grichar 1997).

Devil's-claw control. No herbicide or spray volume controlled devil's-claw more than 63%. Thompson et al (2005) reported that imazapic at 0.04 to 0.07 kg/ha controlled devil's-claw 88 to 94% when applied early postemergence (POST) or late POST.

Silverleaf nightshade control. No herbicide or spray volume controlled silverleaf nightshade greater then 65%. No data could be found on using imazapic or imazethapyr to control silverleaf nightshade.

Puncturevine control. Generally, imazapic provided better puncturevine control than imazethapyr. No data could be found for puncturevine control when using imazapic or imazethapyr. Geier et al (2006) reported that *S*-metolachlor alone provided variable puncturevine control which ranged from 70 to 99% while the addition of atrazine to *S*-metolachlor provided more consistent control of 95 to 100%.

Smellmelon control. Both imazapic and imazethapyr controlled smellmelon at least 97% when applied at 94 L/ha or less. However, when the spray volume was increased to 117 L/ha, smellmelon control with both imazapic and imazethapyr was no greater then 80% with the exception of imazapic at 117 L/ha and imazethapyr at 187 L/ha which controlled smellmelon 100 and 90%, respectively. Smellmelon is becoming more of a problem in south Texas peanut production fields and has become a problem in several crops along the Texas Gulf coast (author's personal observation). Smellmelon can be a problem at peanut harvest as the melon can become broken apart when run through the combine and increase drying time because of the high moisture content of the melon itself (author's personal observation). In corn (*Zea mays* L.), Thompson et al. (2005) reported that imazapic at 0.07 and 0.14 kg/ha applied preemergence (PRE), EPOST, or LPOST controlled smellmelon greater than 90%.

Pitted morningglory control. Both imazapic and imazethapyr controlled pitted morningglory at least 98% when applied at 94 L/ha or less. Imazapic applied at 117 L/ha controlled pitted morningglory 99% but imazethapyr at this spray volume provided only 77% control. When imazapic was applied at 140 to 187 L/ha, pitted morningglory control was 78 to 87% while imazethapyr at these same spray volumes provided 83 to 94% control. Imazapic and imazethapyr have provided excellent morningglory control (Grichar 1997; Richburg et al. 1995). Grichar (1997) found that imazapic at 0.04 and 0.07 kg/ha provided at least 80% pitted morningglory control with early POST and POST applications. Imazapic at 9 g/ha has provided pitted morningglory control which varied from 33 to 85% (Newsom and Shaw 1994). Research by Wilcut et al. (1994) found that imazapic was more effective than imazethapyr applied either PPI, PRE, or early POST.

Prickly sida control. Prickly sida was controlled no less than 99% when applied at 47 to 94 L/ha. At 117 L/ha, imazapic controlled prickly sida 100% while imazethapyr provided only 67% control. At spray volumes above 140 L/ha, only imazethapyr at 164 L/ha or imazapic at 187 L/ha provided at least 85% control. Prickly sida (*Sida spinosa* L.) is mainly a problem in the southeastern peanut growing region (Eric Prostko, personal communication). Bentazon and imazethapyr POST will control prickly sida when applied to small sized plants, but if larger than two-leaf, imazethapyr POST is ineffective (Wilcut et al. 1994). Wilcut et al. (1991a) noted that imazapic controlled five-leaf prickly sida at least 95%.

Weed Control with Different Spray Tips. For annual grass and Palmer amaranth control, there was no spray tip and herbicide by year interaction; therefore, these variables are presented separately. For devil's-claw, pitted morningglory, prickly sida, smellmelon, and silverleaf nightshade, there was no spray tip by herbicide interaction; therefore, these variables are presented separately.

Annual grass control. No difference in Texas panicum (2006) or southern crabgrass (2007) control was noted between spray tips. Texas panicum control varied between 87 to 100% while southern crabgrass control varied from 66 to 78%.

In both years, imazapic provided better grass control than imazethapyr (data not shown). In 2006, imazapic controlled Texas panicum 100% while imazethapyr provided 89% control. In 2007, imazapic provided 85% southern crabgrass control while imazethapyr only controlled 59%.

Palmer amaranth control. At the High Plains location in 2006, poor Palmer amaranth control was noted with all spray tips. Palmer amaranth was controlled 61 to 69% when FF, TT, and DG spray tips were used, while control with XR tips was less than 30%. At the south Texas location, Palmer amaranth was controlled at least 98% with the various tips. At the High Plains location in 2007, Palmer amaranth was controlled 72 to 79% with all spray tips (Table 3). No difference in Palmer amaranth control was noted in 2006 between imazapic and imazethapyr; however, at the southern High Plains location in 2007 imazapic provided better control than imazethapyr.

Smellmelon control. Smellmelon was controlled at least 95% with all spray tips. Imazapic controlled smellmelon better than imazethapyr. Grichar (2007), in a two year study in peanut, reported that imazapic controlled smellmelon 86 to 89% while imazethapyr controlled smellmelon 61 to 76%.

Pitted morningglory control. No difference in pitted morningglory was noted with any spray tip (Table 4) while imazapic provided better control than imazethapyr.

Devil's-claw control. The FF spray tips provided better control of devil's-claw than other spray tips while no difference in control was noted between imazapic and imazethapyr.

Silverleaf nightshade. Control was less than 65% with all spray tips. The TT spray tips provided better control than all tips with the exception of the DG tips. No difference in silverleaf nightshade control was noted between imazapic and imazethapyr.

Prickly sida control. No difference in control was noted with any spray tip with control ranging from 68 to 77%. Imazapic provided perfect control while imazethapyr controlled less than 50%.

Generally, annual grass and Palmer amaranth control was variable with spray volumes. Also, imazapic controlled weeds better than imazethapyr. In south Texas under extremely dry conditions (2006), supplemented by irrigation, spray volume had no effect on Texas panicum control. However, in an above average rainfall year (2007), herbicide efficacy on southern crabgrass decreased as spray volume was increased above 94 L/ha. Control of smellmelon, pitted morningglory, and prickly sida also decreased as spray volume increased. No response to spray volume was noted at the southern High Plains location and this may be due to lower humidities which are generally found in this area. Several studies have reported that spray volume did not influence yellow nutsedge (*Cyperus esculentus* L.) control (Bruce and Kells 1990; Nelson et al. 2002). In contrast, low spray volumes increased annual grass control with glyphosate (Buhler and Burnside 1984). Other studies have reported that herbicide efficacy in low spray volumes is often dependent on the specific adjuvant and adjuvant amount. Conversely, herbicide efficacy generally increased as spray volume increased when adjuvants were applied as a percentage of spray volume (Nalewaja and Ahrens 1998; Ramsdale and Nalewaja 2001).

Also, relative humidity can directly influence herbicide absorption and translocation in plants (Wanamarta and Penner 1989). Relative humidity enhances the absorption and translocation of herbicides in plants by prolonging the drying of the spray droplets on the leaf surface (Wanamarta and Penner 1989), increasing cuticle hydration (Hull 1970), and to a smaller extent by favoring stomatal opening (Hull 1970). This may explain why there was no difference in herbicide efficacy under the low humidity conditions of the High Plains or south Texas in 2006, but under the high humidity conditions observed in south Texas during the 2007 growing season, differences in weed control were noted.

Spray tip had little influence on weed control. Ramsdale et al. (2003) reported that glyphosate applied using TT and TD nozzles controlled oat (*Avena sativa* L.), hard red spring wheat (*Triticum aestivum* L.) , and proso millet (*Panicum miliaceum* L.) equal to that of the XR nozzles. Standard low-input nozzles typically used for low volume applications have a small orifice that is subject to plugging and produce fine spray droplets that are susceptible to spray drift. These nozzle characteristics have deterred the use of low spray volumes, even though low volumes are known to be effective with certain herbicides (Ramsdale et al. 2003). However, drift-reducing nozzles that produce large spray droplets at low spray volumes were equally as effective as the standard low output nozzles in enhancing glyphosate efficacy (Ramsdale and Messersmith 2002).

PART THREE. Survey of Problem Peanut Fields in the High Plains. Cadre (imazapic) and Pursuit (imazethapyr) are imidazolinone herbicides that inhibit acetolactate synthase (ALS) in susceptible plants. Cadre and Pursuit control a broad-spectrum of weeds including annual grass and broadleaf weeds and nutsedge. In west Texas, these herbicides are applied postemergence only and both have good residual soil activity. One of the concerns about the use of Cadre and Pursuit is their rotational restriction to several crops including cotton. According to the Cadre and Pursuit labels, cotton should not be planted within 18-months after application. In recent years, Palmer amaranth (carelessweed) has been more visible in peanut fields treated with Cadre or Pursuit. These escapes may be attributed to application error and environmental conditions, but there is concern that Palmer amaranth may have developed resistance to these ALS-inhibiting herbicides in some instances.

There are several weeds that have been reported to be resistant to herbicides that inhibit ALS. According to the International Survey of Herbicide Resistant Weeds (http://www.weedscience.org/in.asp), which is funded and supported by the Herbicide Resistance Action Committee (HRAC), the North American Herbicide Resistance Action Committee (NAHRAC), and the Weed Science Society of America (WSSA), 317 weed biotypes (183 species) in over 290,000 fields have confirmed incidences of weed resistance. Ninety-five of the weed species have developed resistance to the acetolactate synthase (ALS) inhibiting herbicides. In Texas, we have over 6,700 acres that have been confirmed to contain weed resistance. Perennial ryegrass, barnyardgrass, Palmer amaranth, kochia, and johnsongrass have been reported in Texas. In 2006 and 2007, we looked for problem fields that we thought may contain weed resistance. Unfortunately, no seed was collected from these problem fields to confirm resistance. This survey and collection will continue past this report date. In South Texas, weed resistance in waterhemp and pigweed to the ALS inhibitors may have occurred. Waterhemp seed was collected and sent to Lubbock for testing. Seed was planted in the greenhouse and spray with high rates of Cadre and Pursuit and did not die. Additional tests will be performed to confirm resistance.

A multi-state effort lead by Dr. David Jordan has put together a grower-friendly publication on the status of herbicide resistant weeds in peanut in the United States and management options for these weeds (http://www.peanut.ncsu.edu/ag692color.pdf). This paper was also reprinted in The Peanut Grower, February 2008. Our efforts to identify and management herbicide resistant weeds will continue.