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OUSTAR: A PREMIXED BLEND OF VELPAR DF+OUST XP FOR HERBACEOUS WEED CONTROL AND ENHANCED LOBLOLLY PINE SEEDLING PERFORMANCE

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Abstract—Six tests were established comparing the herbaceous weed control (HWC) and resultant loblolly pine (*Pinus taeda* L.) seedling performance from treatments of Oustar (0, 10, 13, 16, 19 ounces product acre^{-1}), and industry standards (Velpar L+Oust 32+2; Arsenal+Oust 4+2 both in ounces product acre^{-1}). Sites were prepared prior to planting with: burn only, chemical only, mechanical only, or mechanical and chemical methods. Oustar (13 ounces) and industry standards provided similar weed control and seedling performance. The low rate (10 ounces) of Oustar applied to sandy loam soils receiving chemical preparation and plowing prior to planting provided bareground comparable to industry standards. When averaged across test sites, herbicide plots consistently had more bareground than untreated plots by nearly 2x 30 days after treatment (DAT), 3x 60 DAT, 4x 90 DAT, and 5x 120 DAT. Similarly, herbicide plots had more seedling survival (9 percent), total height (0.69 feet), ground line diameter (0.26 inch), and volume index (1.54 cubic feet) than untreated plots.

INTRODUCTION

Herbaceous weeds compete with newly planted loblolly pine (*Pinus taeda* L.) seedlings for water, nutrients, light, and space. Forest managers seeking enhanced survival and seedling growth practice herbaceous weed control (HWC) at planting. Velpar L (liquid) and Oust (dry) are forest herbicides manufactured by E.I. du Pont de Nemours and Company. These products are packaged separately but commonly mixed together in a spray tank to control herbaceous weeds of newly planted pine seedlings. Users must buy, store, and handle both products separately before mixing them on application day. Each gallon of Velpar L contains 25 percent of the active ingredient, hexazinone, plus alcohol and other ingredients for stability and shelf life. The alcohol makes Velpar L more flammable than other forest herbicides. Oust herbicide is a granule containing 75 percent sulfometuron, the active ingredient. The product is pan granulated with chemical binders that hold the dust-like particles together. Oust forms a suspension when added to water. If allowed to sit, particles of Oust settle to the tank bottom. There, the same binders used to hold the dry particles together turn the Oust-particles into a paste. Good agitation prior to spraying moves Oust from the tank bottom and into suspension.

New extruded granular formulations of Oust and Velpar were tested in 1999. Extruded granules lack the chemical binders previously used for pan granules. Consequently, the new formulation, called Oust XP, has improved solubility. If allowed to settle, new Oust XP requires less agitation for resuspension. The new formulation of Velpar L, called Velpar DF, is alcohol-free and 75 percent concentrated. Furthermore, the new granules of Oust XP and Velpar DF are identical in size, shape, and density.

Oustar, developed for testing in 2000, is a premixed blend of Oust XP and Velpar DF. It brings the enhanced properties of the new formulations into one container for increased convenience of storage, handling, and mixing. The objective of this project was to compare Oustar and conventional industry standards (Velpar L+Oust; Arsenal+Oust) for HWC and loblolly pine seedling performance.

METHODS

Field trials were established in March 2000 at six sites: in Diboll and Lufkin, TX; Whitfield, AL; Picayune, MS; Cold Point, SC; and Starkville, MS. The sites were varied in their preparation intensity (table 1). Herbicide treatments were applied pre-emergence at Picayune, Diboll, Cold Point, and Starkville and postemergence at Lufkin and Whitfield. Herbicide treatments were: (1) Oustar 10 ounce, (2) Oustar 13 ounces, (3) Oustar 16 ounces, (4) Oustar 19 ounces, (5) Velpar L+Oust XP 32+2 ounces, (6) Arsenal AC+Oust XP 4+2 ounces, and (7) untreated check. All rates were applied in ounces of product per treated acre.

Treatment plots in Starkville, Diboll, and Lufkin contained 16 seedlings in a single row. Measurement plots were inside treatment plots and contained 12 seedlings with 2 buffer seedlings on each end. In Whitfield, Cold Point, and Picayune, treatment and measurement plots contained 10 seedlings.

Treatments were visually evaluated for percent bareground at 30, 60, 90, and 120 days after treatment (DAT). Seedlings were assessed for survival (percent) and measured for height (HT, in feet), and ground line diameter (GLD, in inches) prior to treatment and after one and two growing seasons. Volume index (VI) was computed as VI = HT X GLD^2 and expressed in cubic feet. Year-1 cover and year-2 growth are presented here.

All test sites had four blocks each. Treatments were assigned to a randomized complete block design. Treatment effects were partitioned using the analysis of variance with means separated using Duncan's New Multiple Range Test ($P \leq 0.05$).

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Table 1—A summarized description of test sites

Site	Picayune, MS	Diboll, TX	Lufkin, TX
Established	2000	2000	2000
Physiography	Flatwoods LCP	Hilly UCP	Hilly UCP
Soil	Silt loam pH 4.2	Sandy loam pH 5.4	Sandy loam pH 5.0
Harvested	Dec 98	Sep 98	May 99
Site Prep1	Oct 99 Shear, rake Windrow	Sep 99 Arsenal + Garlon 4 16 oz + 2 qt	Aug 99 Wildfire —
Site Prep2	Dec 99 Burned windrows Planted Jan 00 Bare root, hand	Oct 99 Combination plow Jan 00 Container, hand	— — Jan 00 Bare root, hand
Treated Percent Cover	5 Apr 00 < 1 percent @ 6" Pre-emergence	14 Apr 00 < 1 percent @ 6" Pre-emergence	15 Apr 00 < 40 percent @ 6" Post-emergence
Treatments Total volume	5-foot band 10 GPA	5-foot band 10 GPA	5-foot band 10 GPA
Major Forbs	*Eupatorium spp* *Rubus spp*	*Eupatoriium spp* *Erechtites spp* *Croton spp*	*Eupatorium spp* *Conyza spp*
Major grasses	*Panicum spp*	—	*Panicum spp* Dicanthelium spp *Andropogon spp*

Site	Cold Point, SC	Whitfield, AL	Starkville, MS
Established	2000	2000	2000
Physiography	Piedmont	Interior flatwood LCP	Hilly UCP
Soil	Sandy loam pH 5.4	Sandy loam pH 4.2	Sandy clay loam pH 5.2
Harvested	Jul 98	Dec 98	May 99
Site Prep1	May 99 Chopper + oil 48 oz + 5 qt	Jul 99 Shear, rake windrow —	Aug 99 Chopper+Accord SP 48 oz + 4qt
Site Prep2	Dec 99 Combination plow	— —	Oct99 Burned
Planted	Jan 00 Bare root, hand	Jan 00 Bare root, machine	Jan 00 Bare root, hand
Treated Total Volume Percent Cover	13 Apr 00 10 GPA < 10 percent @ 6" Pre-emergence	6 Apr 00 10 GPA < 80 percent @ 12" Post-emergence	10 Apr 00 10 GPA < 10 percent @ 6" Pre-emergence
Treatments	5-foot band	5-foot band	5-foot band
Major Forbs	*Ambrosia spp* *Rubus spp*	*Eupatorium spp* *Erechtites spp* *Ambrosia* spp	*Eupatorium spp* *Conyza spp*
Major Grasses	*Panicum spp* *Dicantheium* spp *Andropogon* spp	*Panicum spp* *Dicanthelium* spp	*Panicum spp* *Dicanthelium* spp *Andropogon* spp

LCP=lower coastal plain; UCP=upper coastal plain

RESULTS

Mean Bareground

Bareground values were averaged across all six sites and presented in table 2 for each evaluation date. At 30 DAT, all herbicide test treatments were similarly weed free. At 60 DAT, bareground on plots receiving 10 ounces of Oustar was less than the weed-free value for higher Oustar rates but similar to industry standards. At 90 DAT, herbicide treatments provided very similar weed control, with differences detected among the highest (84 percent) and lowest (76 percent) levels of bareground. At 120 DAT, bareground was similar for all herbicide treatments.

Table 2—Mean bareground (percent) 30 through 120 days after treatment (DAT) with Oustar and industry standards (Velpar L+Oust XP (V+O); Arsenal+Oust XP (A+O)) for herbaceous weed control at six sites

Site	Oustar				V+O	A+O		Site by	Site
DAT	10	13	16	19	32+2[a]	4+2[a]	Check	DAT mean[b]	mean[c]
Overall Mean									
30	91a[d]	94a	95a	96a	93a	91a	46b		
60	84b	90a	92a	90a	89ab	88ab	32c		
90	76b	81ab	84a	80ab	81ab	79ab	22c		
120	61a	65a	65a	69a	67a	66a	12b		
Cold Point, SC									69bc
30	85a	89a	91a	94a	82a	86a	65b	85bc	
60	81a	87a	83a	85a	77a	87a	44b	78c	
90	76a	67a	65a	73a	64a	62a	31b	62b	
120	53a	48ab	55a	66a	48ab	48ab	26b	49b	
Diboll, TX									86a
30	93a	99a	99a	100a	99a	99a	28b	88b	
60	94a	97a	98a	99a	97a	99a	28b	87b	
90	90a	96a	96a	99a	97a	99a	28b	86a	
120	92a	92a	72a	99a	97a	96a	18b	81a	
Lufkin, TX									71b
30	93a	99a	99a	100a	99a	99a	13b	86bc	
60	78b	85b	93a	94a	85b	84b	6d	75c	
90	68c	75b	83a	84a	75b	74b	2d	66b	
120	53c	60b	71a	74a	64b	60b	2d	55b	
Picayune, MS									89a
30	95ab	98a	97a	99a	98a	99a	92b	97a	
60	92a	96a	96a	96a	98a	97a	75b	93a	
90	90a	96a	95a	97a	98a	95a	51b	89a	
120	75b	89ab	95a	94a	92a	84ab	12c	77a	
Starkville, MS									68bc
30	92a	90a	91a	90a	91a	93a	37b	84bc	
60	87a	86a	87a	84a	89a	83a	17b	76c	
90	70ab	57b	68ab	67ab	75ab	80a	5c	60b	
120	63ab	48b	62ab	52b	62ab	68a	5c	51b	
Whitfield, AL									64c
30	88ab	88ab	93a	95a	91a	73b	41c	81c	
60	73c	91ab	97a	81bc	91ab	79bc	18d	76c	
90	59c	89ab	96a	60c	77abc	68bc	14d	66b	
120	29b	47a	38ab	29b	39ab	38ab	9c	32c	

[a] Ounces of product per acre.
[b] DAT means within a column sharing the same letter are not significantly different (Duncan's New Multiple Range Test ($P \leq 0.05$).
[c] Site means within a column sharing the same letter are not significantly different (Duncan's New Multiple Range Test ($P \leq 0.05$).
[d] Treatment means within a row sharing the same letter are not significantly different (Duncan's New Multiple Range Test ($P \leq 0.05$).

As the growing season progressed, the values for bareground showed little range variation between Oustar use rate and industry standards (table 2). For example, bareground at 30 DAT ranged only 5 percent, from a low of 91 to a high of 96 percent for Oustar treatments; at 60 DAT, the range was 8 percent from 84 to 92 percent; at 90 DAT, the range was 8 percent from 76 to 84 percent; and at 120 DAT, the range was 8 percent from 61 to 69 percent. For all evaluation dates, industry standards consistently provided weed-free growing space intermediate between the low and high Oustar test rates.

Herbicide treatments consistently exhibited more weed-free growing space than that observed on untreated checks (table 2). The mean bareground of all herbaceous weed treatments compared with the untreated check was nearly 2x 30 DAT, 3x 60 DAT, 4x 90 DAT, and 5x 120 DAT.

Bareground by Site

Mean percent bareground varied by site (table 2). Weed-free conditions were highest and similar at Picayune (89 percent) and Diboll (86 percent). Bareground at Lufkin (71 percent) was intermediate and similar to that at Cold Point (69 percent) and Starkville (68 percent). Bareground was lowest at Whitfield (64 percent) but similar to that at Cold Point and Starkville. For all evaluations, sites averaged at least 64 percent weed-free.

The site by DAT means show the speed with which herbicide treatments provided bareground (table 2). For example, at 60 DAT, percent bareground was statistically Picayune> Diboll>Lufkin=Cold Point=Starkville=Whitfield and numerically 93, 87, 75, 78, 76, and 76 percent, respectively. At 120 days, bareground was statistically Diboll=Picayune> Lufkin=Starkville=Cold Point>Whitfield and numerically 81, 77, 55, 51, 49, and 32 percent, respectively. Picayune and Diboll sites on application day had the lowest ground cover at less than one percent. Whitfield on application day had the highest ground cover at almost 80 percent. Sites with less ground cover on application day exhibited more bareground at 60 and 120DAT and generally at all evaluations than sites with high levels of cover.

The sites by DAT means illustrate the duration of weed control (table 2). For example, at Cold Point, bareground peaked 30 DAT (85 percent) and was lowest 120 DAT at 49 percent, a decline of 36 percent. During this same period, Diboll was 88 and 81 percent, Lufkin was 86 and 55 percent, Picayune was 97 and 77 percent, Starkville was 84 and 51 percent, and Whitfield was 81 and 32 percent, respectively.

The sites by herbicide by DAT means show high rates of Oustar (16 ounces, 19 ounces) provided best and similar weed control across all sites (table 2). Weed control among use rates of Oustar and industry standards was similar at Cold Point, Diboll, and Picayune (table 2). For example, at Cold Point 30 DAT, Oustar treatments, industry standards, and all herbicide treatments averaged 90, 84, and 88 percent bareground, respectively; at 60 DAT, the averages were 84, 82, and 83 percent; at 90 DAT, the averages were 70, 63, and 68 percent; and at 120 DAT, the averages were 56, 48, and 53 percent. These data illustrate the potential contribution of quality and timely site preparation to stage of weed development on application day and the performance of Oustar and industry standards. For example, October mechanical site preparation (Picayune) and chemical followed by mechanical site preparation (Diboll and Cold Point) yielded modest herbaceous weed levels (highest at Cold Point: 90 percent bareground and < 10 percent cover 6 inches tall) readily controlled by herbicides. This gives managers HWC options during tight budgets.

Unexpected patterns in herbicide performance at Lufkin, Starkville, and Whitfield may be explained by site preparation method, timing of the method, and species composition of weed recolonization. For example, Lufkin was prepared by a wildfire. Only high rates of Oustar (16 ounces, 19 ounces) sustained best weed control through 120 DAT. Low rates of Oustar and industry standards performed well early but gradually succumbed to weed pressure. This was the only test site where industry standards were not among the best treatments tested. At Starkville, plots treated with Oustar 13 ounces were coincidentally colonized by blue vervain (*Verbena brasiliensis* Vell.), to a greater extent than plots treated with other herbicides. Blue vervain is tolerant of hexazinone and sulfometuron, the active ingredients in Oustar. Managers have little influence on seed in the soil or that blowing in following herbicide application and subsequently colonizing treatment areas. At Whitfield, mechanical preparation in July left plenty of time for autumn weed seed dissemination of plots. This was evident on application day, when weeds nearly 1foot tall occupied approximately 80 percent of the site. Heavy weed development on application day was followed by the most aggressive weed re-colonization of all plots at all sites 120 DAT. The Lufkin and Whitfield sites illustrate the need for quality and timely site preparation prior to planting.

Bareground by Site Preparation Method

When sites were analyzed for bareground by site preparation method, HWC was similar 30 DAT for the mechanical (mech), chemical+mechanical (c+m), wildfire, or chemical methods (table 3). At 60 and 90DAT, HWC was similar and better for sites mech (Picayune and Whitfield) and c+m prepared (Cold Point and Diboll Cold Point). Similar and lowest HWC resulted from the wildfire (Lufkin) and chemical (Starkville) site preparations. At 120 DAT, the c+m prepared sites had more HWC than the site prepared only with herbicides (Starkville).

Bareground was averaged across evaluation dates to produce means for the entire growing season (table 3). Bareground following a wildfire (Lufkin) was statistically similar but numerically less than for mech (Picayune and Whitfield) and c+m (Cold Point and Diboll) prepared sites. Furthermore, bareground following a wildfire was statistically similar and numerically greater than for the chemically prepared site (Starkville). Data illustrate herbicide treatments were well suited for weed conditions following a variety of site preparation methods providing at least 68 percent bareground for the evaluation period at all sites.

Table 3—Mean bareground (percent) for site preparation methods

		Days after treatment				
Site	Site preparation	30	60	90	120	Overall
Picayune, MS Whitfield, AL	Shear, rake, windrow & burn Shear, rake, windrow	89a[a]	84a	77a	55ab	76a
Cold Point, SC Diboll, TX	Chopper + plow Arsenal + Garlon + plow	86a	82a	74a	65a	77a
Lufkin, TX	Wildfire	86a	75b	60b	55ab	70ab
Starkville, MS	Chopper + Accord SP & burn	84a	76b	66b	51b	68b

[a] Treatment means within a column sharing the same letter are not significantly different (Duncan's New Multiple Range test, $P \leq 0.05$ level).

Seedling Performance

Seedling performance after two growing seasons was averaged across all six sites. HWC increased survival (7.2 percent), total HT (0.47 foot), GLD (0.22 inch), and VI (1.22 cubic feet) above that of untreated checks. In a three-way comparison of seedlings treated with Oustar, industry standards, or nothing (untreated checks), seedling performance was similar for Oustar treatments and industry standards and both significantly better than untreated checks. For example, for the three-way comparison, survival was 85.4, 87.1, and 78.7 percent; total HT was 5.1, 5.4, and 4.7 feet; GLD 1.41, 1.48, and 1.21 inches; and VI 5.48, 6.16, and 4.48 cubic feet, respectively.

Seedling performance varied by site (table 4). Survival was, statistically, Picayune=Whitfield=Diboll>Starkville> Cold Point>Lufkin and numerically 99, 98, 97, 85, 73, and 66 percent, respectively. For total HT, statistically, Whitfield>Picayune> Starkville>Diboll>Lufkin>Cold Point and numerically 6.8, 6.4, 5.5, 4.9, 4.2, and 2.3 feet, respectively. For GLD, statistically, Picayune>Whitfield= Diboll>Lufkin>Starkville>Cold Point and numerically 1.76, 1.65, 1.58, 1.35, 1.26, and 0.51 inches, respectively. For VI, statistically, Whitfield=Picayune>Diboll=Starkville> Lufkin>Cold Point and numerically, 8.12, 8.03, 5.79, 5.26, and 0.93 cubic feet, respectively.

Table 4—Seedling survival (percent), total height (feet), ground line diameter (GLD, inches), and volume index (VI, cubic feet) two growing seasons following treatment at six sites with Oustar or industry standards (Velpar L+Oust XP (V+O); Arsenal+Oust XP (A+O)

Site	Oustar					V+O	A+O	Site
Parameter	10	13	16	19	32+2[a]	4+2[a]	Check	Mean
Overall Means								
Survival[b]	86.8a	84.5ab	85.0ab	85.4ab	85.4ab	88.7a	78.7b	
Total Height[b]	5.0bc	4.9cd	5.2ab	5.1bc	5.5a	5.3ab	4.7d	
GLD[b]	1.33d	1.39cd	1.51a	1.40bcd	1.47abc	1.49ab	1.21e	
VI ($x10^{-2}$) [b]	5.11b	5.15b	6.06a	5.59ab	6.20a	6.11a	4.48c	
Cold Point, SC								
Survival	87.5a	75.0a	62.5a	83.3a	66.7a	70.8a	61.1a	72.8c[c]
Total Height	2.8a	2.6ab	2.3ab	1.7c	2.4ab	2.2bc	2.2b	2.3f
GLD	0.58a	0.58a	0.48a	0.31b	0.52a	0.52a	0.55a	0.51e
VI ($x10^{-2}$)	1.24a	1.18a	0.83ab	0.37b	1.0a	0.92a	1.0a	0 .93d
Diboll, TX								
Survival	97.9a	97.9a	97.9a	93.8a	93.8a	100.0a	95.8a	96.7a[c]
Total Height	4.7b	4.7b	5.1ab	4.8ab	5.4a	4.8b	5.1ab	4.9d
GLD	1.45c	1.60abc	1.67ab	1.58abc	1.73a	1.53abc	1.48bc	1.58b
VI ($x10^{-2}$)	5.11b	5.44b	6.19ab	5.71b	6.90a	5.70b	5.52b	5.79b
Lufkin, TX								
Survival	64.6a	75.0a	70.8a	66.7a	66.7a	70.8a	43.8b	65.5d[c]
Total Height	4.0a	4.3a	4.4a	4.6a	4.4a	4.3a	3.0b	4.2e
GLD	1.24bc	1.37ab	1.44ab	1.45a	1.36ab	1.38ab	1.12c	1.35c
VI ($x10^{-2}$)	3.58b	4.26ab	4.54ab	4.84a	4.46ab	4.53ab	2.42c	4.19c
Picayune, MS								
Survival	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	91.7b	98.8a[c]
Total Height	6.2ab	5.6b	6.4a	6.5a	6.9a	6.6a	6.5a	6.4b
GLD	1.63c	1.65bc	1.85ab	1.77abc	1.82abc	1.94a	1.68bc	1.76a
VI ($x10^{-2}$)	7.24bc	6.56c	8.44ab	8.13abc	9.01a	8.95a	7.91abc	8.03a
Starkville, MS								
Survival	86.7ab	71.1b	84.4ab	82.2b	91.1a	93.3a	86.7ab	85.1b[c]
Total Height	5.9abc	5.2d	5.5bcd	5.3cd	6.1ab	6.3a	4.0e	5.5c
GLD	1.31bc	1.17c	1.38ab	1.28cb	1.31bc	1.56a	0.79d	1.26d
VI ($x10^{-2}$)	5.71b	4.56b	5.65b	5.15b	5.82b	7.19a	2.36c	5.26b
Whitfield, AL								
Survival	95.8a	95.8a	95.8a	100.0a	100.0a	100.0a	100.0a	98.2a[c]
Total Height	6.5ab	6.7ab	7.2a	7.3a	6.9ab	6.6ab	6.1b	6.8a
GLD	1.61a	1.63a	1.83a	1.74a	1.72a	1.68a	1.33b	1.65b
VI ($x10^{-2}$)	7.44bc	8.10ab	9.61a	8.85ab	8.61ab	8.15ab	6.14c	8.12a

[a] Ounces of product per acre.

[b] Treatment means within a row sharing the same letter are not significantly different (Duncan's New Multiple Range Test ($P \leq 0.05$).

[c] Site means for each seedling parameter within a column sharing the same letter are not significantly different (Duncan's New Multiple Range Test ($P \leq 0.05$).

Herbicide treatments commonly enhanced seedling survival and growth over untreated checks. In a comparison of treated versus untreated, performance was significantly enhanced for survival at Lufkin, Picayune, Starkville, and overall; total HT at Lufkin, Starkville, Whitfield, and overall; GLD at Diboll, Lufkin, Picayune, Starkville, Whitfield and overall; and VI at Diboll, Lufkin, Picayune, Starkville, Whitfield, and overall.

In a comparison of Velpar L+Oust (32+2 ounces) and Oustar (13 ounces) formulations, Velpar L+Oust enhanced total HT at Diboll and Picayune; and VI at Diboll and Picayune. GLD was similar at all sites. In a comparison of Arsenal (4+2ounces) and Oustar (13ounces), Arsenal+Oust enhanced total HT, GLD, and VI at Picayune. Starkville was not included in these analyses because of the invasion of blue vervain in the Oustar (13 ounces) treatment only.

As the rate of Oustar increased, GLD decreased at Cold Point and Diboll (table 5). Significant linear and negative quadratic estimates were detected at both sites and illustrate the risk of high application rates on plowed, sandy loam soils with inadequate rainfall for bed settlement.

In conclusion, weed control and seedling performance were very similar for several rates of Oustar. When compared to industry standards, comparable rates of Oustar provided similar weed control, seedling survival, and growth. Results show the potential of Oustar for safe HWC and enhanced loblolly pine seedling performance.

Table 5—Age two regression relationships for Oustar rate (10, 13, 16, 19 ounces product per acre) and ground line diameter resulting from post-plant herbaceous weed treatments on chemically prepared and plowed sandy loam soils with inadequate rainfall for good early bed settlement

	Cold Point			Diboll		
	Intercept b_0	Linear b_1	Quadratic b_2	Intercept b_0	Linear b_1	Quadratic b_2
Coefficient	-0.0267	0.1086	-0.0048	0.0198	0.2096	-0.0667
Coefficient Pr > F		0.1560	0.0703		0.0528	0.0717
Model Pr > F			0.0001			0.0596