Auburn University
Southern Forest Nursery
Management Cooperative

RESEARCH REPORT 14-06

EFFECT OF RONSTAR® FLO, ALONE AND IN TANK MIXES WITH PENDULUM® AQUACAP™ AND GOAL® 2XL AT THE TIME OF SOWING ON THE PRODUCTION OF LOBLOLLY PINE AND WEED CONTROL IN FIVE DIFFERENT NURSERIES

by
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INTRODUCTION

Ronstar® Flo is a pre-emergence herbicide for the control of annual grasses and broadleaf weeds in commercial nursery beds sold by Bayer CropScience. The active ingredient is oxadiazon, 34.1% and is sold under other trade names Oxadiazon SC (Quali-Pro). The literature on Ronstar suggests that the herbicide controls weeds through shoots, not roots and is a common herbicide used on turf grasses to control broadleaved weeds (Duke et al 1989). In addition, the herbicide can be applied to sensitive grasses and areas where roots are already weakened by winterkill. Data from Bayer CropScience suggests that the compound works on warm-season turf grasses and one pre-emergent application, even in cool weather (time of sowing seed beds), or weeks before seed germination will control weeds all season long. Some of the weed pests listed include many found in nursery production systems. These include the broadleaf weeds: bittergrass, bristly oxtongue, carpetweed, cheeseweed, common groundsel, common purslane, evening primrose, ragwort, lambsquarters, liverwort, oxalis, Pennsylvania smartweed, prostrate spurge, redroot pigweed, sow thistle, speedwell, spotted catsear, swinecress, yellow woodsorrel, as well as some grassy weeds that appear in nurseries: annual bluegrass, barnyardgrass, carpetgrass, crabgrass, fall panicum, goose grass, green foxtail, and wild oats. With such a wide array of weeds controlled, the Nursery Cooperative continues to test as a pre-emergent labeled for use on commercial nurseries. A previous study at the Quail Ridge Nursery in Aiken found that pre-emergent applications containing Ronstar® Flo controlled the annual sedge population throughout the growing season on plots were monitored. In that trial, all pre-emergent applications of Ronstar® Flo contained between 2 -7% annual sedge compared to the operational control containing 69% annual sedge near the end of the growing season (Enebak et al 2013). Therefore, the objectives in this trial were to evaluate loblolly pine (Pinus taeda) seedling tolerance to pre-emergent applications of Ronstar® Flo (34.1% oxadiazon) alone and with different combinations and at different application rates with Pendulum® AquaCap™ (38.7% pendimethalin), and Goal® 2XL (22.3% oxyfluorfen) on a wide array of nursery soil textures. In addition to seedling tolerance, weed control would be determined following pre-emergent applications of these herbicides.

METHODOLOGY

All pre-emergent herbicide treatments were applied by AU Nursery Cooperative personnel using

a CO_2 hand sprayer calibrated to broadcast a spray volume of 25 gallons per acre as outlined in Table 1. Each treatment plot was one seedling bed wide by 10 feet in length and replicated five times along the nursery bed. The use of 250 feet (10 ft plots X 5 treatments X 5 replications) of nursery bed space was used in each of the 5 different nurseries the experiment was installed. The nurseries involved included the Georgia Forestry Commissions nursery in Byromville, GA (Flint River), Plum Creek's nursery in Jesup, GA (Jesup), Weyerhaeuser's nursery in Camden, AL (Pine Hill), Native Forest's nursery in Chatsworth, GA (Chatsworth) and Rayonier's nursery in Elberta, AL (Elberta). These nurseries were chosen for their proximity to Auburn as well as their various soil types which reflect a wide range from sandy loams to silt loams (Table 2). Historically, soil type has some influence on the performance of untested herbicides. Prior to the herbicide applications, soil samples were collected and returned to Auburn to determine soil organic matter, pH and soil texture. At each nursery, the experimental data collection included the establishment of permanent plots to determine weed populations that were evaluated during the growing season for all treatments and seedling morphology characteristics at the end of the growing season in November 2013. At the end of the growing season (November for all experiments), seedlings in each treatment plot were lifted from inside a 9 x 48 inch frame placed in the center of the plot. At the Nursery Cooperative laboratory at Auburn University, seedling density, root collar diameter, height, and root/shoot dry weights were measured to determine seedling tolerance to the herbicide treatments that compared Ronstar® Flo to the controls and to the combinations of the other two herbicides used (PAC and Goal).

RESULTS AND DISCUSSION

The application of Ronstar® Flo at the time of sowing at five different nurseries differing in soil texture had no negative effect on loblolly pine seedling densities over the growing season nor was there any negative effect on the loblolly seedling characteristics measured at the time of lifting in November 2013. This can be seen in Tables 3-7. At the Pine Hill Nursery in Camden, AL, the application of Ronstar® Flo at the high rate (80 oz/a) in combination with Pendulum® AquaCap™ and Goal® 2XL resulted in larger seedling shoot weight (ShtWgt) over the control, 2.89 and 3.09 vs 2.52, respectively (Table 7). Often, larger seedlings are due to a reduction in seedling densities; however, this was not the case at the Pine Hill nursery as seedling densities were similar. An increase in RCD over the non-treated control was observed at the Rayonier Nursery in Elberta, AL (Table 6). A similar increase in seedling size with oxadiazon was observed in 2000 when the new formulation was tested at the Alabama Forestry Commission's Atmore nursery (South 2000). Soils in the five nurseries tested ranged from sands to loamy sands, thus soil texture does not seem to be a factor in the herbicides' performance. Thus, loblolly pine has good tolerance to oxadiazon and is another herbicide choice to control weed seed that may germinate later in the season. Ronstar® Flo is also compatible with tank mixes of Pendulum® Aquacap™ and Goal 2XL (RPG) as seedling quality and quantity were also unaffected when compared to the untreated control plots (Tables 3-7). Another important factor in these herbicide trials is that not a single herbicide gall was found on any of the seedlings that were measured from the plots that received Pendulum® AquaCap™ at the time of sowing. Previous trials have shown that when used at the time of sowing, Pendulum® AquaCap™ gives good prostrate spurge control, without the formation of herbicide galls, even at the high rates of 68 oz/ac.

As far as weed control over the growing season, treatments with Ronstar® alone (40 or 80 oz/a) did not provide as much weed control as treatments that contained Pendulum® AquaCap™ and Goal RPG 40 and RPG 80 (Tables 3-7). The lack of weed control over time when compared to the tank mixes is evident in the figures for each nursery tested (Figures 1-5). There was significant weed control with Ronstar® Flo in May at all five nurseries when compared to the non-treated control plots, however, by June herbicide activity of Ronstar® Flo alone was not as evident at Flint River or Jesup nurseries, Figure 1 and 2, respectively. Weed control with Ronstar® Flo was still significantly better than non-treated plots in June at Native Forest Nursery (Figure 3), the Rayonier Nursery (Figure 4) and Pine Hill Nursery (Figure 5). Due to Ben Whitaker's departure from the Nursery Cooperative, weed data was not collected beyond June except at the Pine Hill Nursery where Ronstar® Flo alone was no longer significantly different than the non-treated controls (Figure 5). Clearly, in all nurseries tested, the higher rate of Ronstar® Flo (80 oz/ac) has more activity than the lower rate (40 oz/ac) as there is a stair-step effect when the Control, 40 and 80 oz/ac are examined (Figures 1-5). Unfortunately, the variation and non-uniform distribution of weeds in a nursery bed does not allow a statistical separation of the two Ronstar® Flo treatments. So, even though the means for the higher rate is less than the means for the lower rate, we cannot say, with 95% confidence that the means are different. In contrast, nursery seed beds that received tank mixes all three herbicides (Ronstar®, Pendulum® AquaCap™ and Goal® 2 XL) had significantly fewer weeds than the non-treated controls through June and July (Pine Hill). The extended weed control data collected at this nursery indicates could be due to either Pendulum® AquaCap™ and/or the Goal®2XL that was in these treatments.

Another factor to consider for the short weed control with Ronstar® Flo (when compared to the RPG treatments) is the amount of rain during the growing season. In the eastern US, nurseries such as Flint River and Jesup had normal rainfall in April and May. However, in June and July the bottom dropped out. June and July were the wettest months on record (118 years) for several of these nurseries (Figure 6). Managers at these nurseries indicated to us that, due to the rain, nothing lasted long, even suggesting that some herbicides "*just got washed down to China*". Since Ronstar® Flo acts on foliage alone, June weeds could have been higher at least with Ronstar® Flo alone as this herbicide does not form a soil barrier like Goal® 2XL and Pendulum® AquaCap™ do.

MANAGEMENT IMPLICATIONS

- Loblolly pine is tolerant to pre-emergent applications of Ronstar® Flo at all rates tested. Seedling quality and quantity was unaffected by the herbicide at all five nurseries. This herbicide could be considered as part of a nursery's weed control tools.

- Weed control is better when the higher rate (80 oz/a) is used than the lower rate (40 oz/a) when comparing the Ronstar® Flo alone treatments.

- Weed control with Ronstar® Flo does not last as long as did the tank-mixes that included Pendulum® AquaCap™ and Goal® 2 XL. Excessive rainfall could have had a factor in this at the Georgia nurseries. Multiple applications may increase Ronstar® Flo's effectiveness.

- Pendulum® AquaCap™ applied at the time of sowing did not result in the formation of herbicide galls.

LITERATURE CITED

Enebak, S.A., Whitaker, B., Brooks, B. and Jackson, D.P. 2013. Annual sedge (*Cyperus compressus*) control in loblolly pine. Research Report 13-04. Southern Forest Nursery Management Cooperative, Auburn University 8 pp.

Duke, S.O., Lydon, J. and Paul, R. 1989. Oxadiazon activity is similar to that of p-nitro-diphenyl ether herbicides. Weed Science. 37:152-160.

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Table 1. Herbicide applied as a pre-emergent application and rate used for each treatment.

Treatment	**Pre-emergent Herbicide** *(Trade Name)*	**Active Ingredient**	**Product** *(oz/ac)*
Check	*Control*	-	-
Ron40	Ronstar® Flo	34.1 % oxadiazon	40
Ron80	Ronstar® Flo	34.1 % oxadiazon	80
RPG 40	Ronstar® Flo, Pendulum® AquaCap™, Goal® 2XL	38.7% pendimethalin 22.3% oxyfluorfen	40+34+32
RPG 80	Ronstar® Flo, Pendulum® AquaCap™, Goal® 2XL	38.7% pendimethalin 22.3% oxyfluorfen	80+68+64

Table 2. Soil properties at each of the forest-tree nurseries with trials using Ronstar® Flo – 2013.

Nursery	Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (%)	Soil pH
Flint River, GA	Loamy Sand	88.8	7.9	3.2	1.2	6.3
Jesup Nursery, GA	Sandy Loam	84.9	7.2	7.9	1.2	5.7
Native Forest, GA	Sandy Loam	63.9	28.8	7.2	2.9	5.9
Elberta, AL	Sandy Loam	79.5	11.9	8.5	1.1	5.2
Pine Hill, AL	Sandy Loam	79.8	11.6	8.5	0.9	5.4

Table 3. Herbicide weed control and seedling production and characteristics of loblolly pine treated with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Flint River Nursery in Byromville, GA 2013.

	Weeds (No. / 40 ft^2)		Seedling Densities		Seedling Characteristics							
	May	June	June (ft^2)	Nov (ft^2)	RtWgt (g)	ShtWgt (g)	RWR (%)	ShtHgt (cm)	RCD (mm)	Plantable (ft^2)	Culls (ft^2)	Galls (ft^2)
Check	7.0	37.0	32.6	31.3	0.61	2.73	18.5	29.1	4.21	12.4	19.4	0
Ron40	2.6*	28.0	32.2	30.3	0.68	2.95	18.9	29.2	4.29	13.5	17.8	0
Ron80	1.2*	19.0	31.3	31.8	0.69	2.79	19.7	28.3	4.25	11.5	19.1	0
RPG 40	0.4*	1.6*	30.8	32.1	0.57	2.61	18.1	29.3	4.09	13.4	17.4	0
RPG 80	0.0*	0.2*	30.4	28.8	0.60	2.93	16.9	30.0	4.32	16.3	13.3*	0

[1]Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

Table 4. Herbicide weed control and seedling production and characteristics of loblolly pine treated with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Plum Creek Nursery in Jesup, GA 2013.

	Weeds (No. / 40 ft^2)		Seedling Densities		Seedling Characteristics							
	May	June	June (ft^2)	Nov (ft^2)	RtWgt (g)	ShtWgt (g)	RWR (%)	ShtHgt (cm)	RCD (mm)	Plantable (ft^2)	Culls (ft^2)	Galls (ft^2)
Check	3.5	79.0	25.5	23.8	1.00	3.34	23.4	26	4.82	18.4	5.4	0
Ron40	0.4*	47.2	25.8	25.6	1.02	3.72	21.6	26.9	5.11	20.0	5.6	0
Ron80	0.4*	41.0	27.6	23.7	1.04	3.76	21.8	26.9	5.18	19.6	4.2	0
RPG 40	0.4*	21.2*	25.4	24.1	1.15	4.00	22.6	28.2	5.33	20.2	3.8	0
RPG 80	0.0*	19.2*	26.2	23.8	1.11	3.94	21.8	27.5	5.26	19.4	4.4	0

[1]Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

Table 5. Herbicide weed control and seedling production and characteristics of loblolly pine treated with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Native Forest Nursery in Chatsworth, GA 2013.

	Weeds (No / 40 ft2)		Seedling Densities		Seedling Characteristics							
	May[1]	June	June (ft2)	Nov (ft2)	RtWgt (g)	ShtWgt (g)	RWR (%)	ShtHgt (cm)	RCD (mm)	Plantable (ft2)	Culls (ft2)	Galls (ft2)
Check	45.0	60.0	23.6	20.1	0.65	4.46	12.6	31.9	5.15	17.3	2.8	0
Ron40	8.4*	23.4*	22.7	22.7	0.73	4.92	13.0	32.9	5.32	18.5	4.1	0
Ron80	14.0*	29.0*	21.5	16.8	0.76	5.12	12.9	31.8	5.49	14.0	2.8	0
RPG 40	11.0*	26.0*	19.4	17.5	0.70	4.75	12.9	32.1	5.39	14.9	2.6	0
RPG 80	8.2*	23.2*	19.1	15.0	0.78	4.98	13.6	30.2	5.40	12.7	2.3	0

[1]Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

Table 6. Herbicide weed control and seedling production and characteristics of loblolly pine treated with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Rayonier Nursery in Elberta, AL 2013.

	Weeds (No/40 ft^2)		Seedling Densities		Seedling Characteristics							
	May[1]	June	June (ft2)	Nov (ft2)	RtWgt (g)	ShtWgt (g)	RWR (%)	ShtHgt (cm)	RCD (mm)	Plantable (ft2)	Culls (ft2)	Galls (ft2)
Check	29.0	41.0	16.6	15.2	1.00	4.07	19.7	29.9	5.46	14.2	1.0	0
Ron40	2.4*	11.1*	15.6	15.0	1.03	4.65	17.9	32.9*	5.71	14.4	0.58	0
Ron80	2*	13.5*	13.9	13.0	1.28	4.87	20.6	30.7	5.85	12.7	0.28	0
RPG 40	0.6*	11.6*	14.2	14.4	1.35	5.18*	20.7	31.9	6.05	14.0	0.4	0
RPG 80	0*	9.8*	14.3	13.5	1.14	4.82	19.1	32.1	5.91	13.2	0.34	0

[1]Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

Table 7. Herbicide weed control and seedling production and characteristics of loblolly pine treated with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Pine Hill Nursery in Camden, AL 2013.

	Weeds (No. / 40 ft^2)		Seedling Densities		Seedling Characteristics							
	May[1]	June	June (ft^2)	Nov (ft^2)	RtWgt (g)	ShtWgt (g)	RWR (%)	ShtHgt (cm)	RCD (mm)	Plantable (ft^2)	Culls (ft^2)	Galls (ft^2)
Check	13.0	42.6	28.6	26.6	0.716	2.53	22.1	24.4	4.07	12	14.6	0
Ron40	1.8*	15.2*	29.1	27.5	0.704	2.55	21.6	25.0	4.05	12.3	15.1	0
Ron80	3.6*	10.4*	27.4	24.1	0.759	2.89*	20.7	24.9	4.22	12.5	11.6	0
RPG 40	0.6*	3.4*	29.2	27.6	0.735	2.63	21.8	25.6	4.07	12.1	15.5	0
RPG 80	0.2*	2.4*	27.1	24.6	0.794	3.09*	20.4	26.4*	4.31*	15	9.5	0

[1]Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

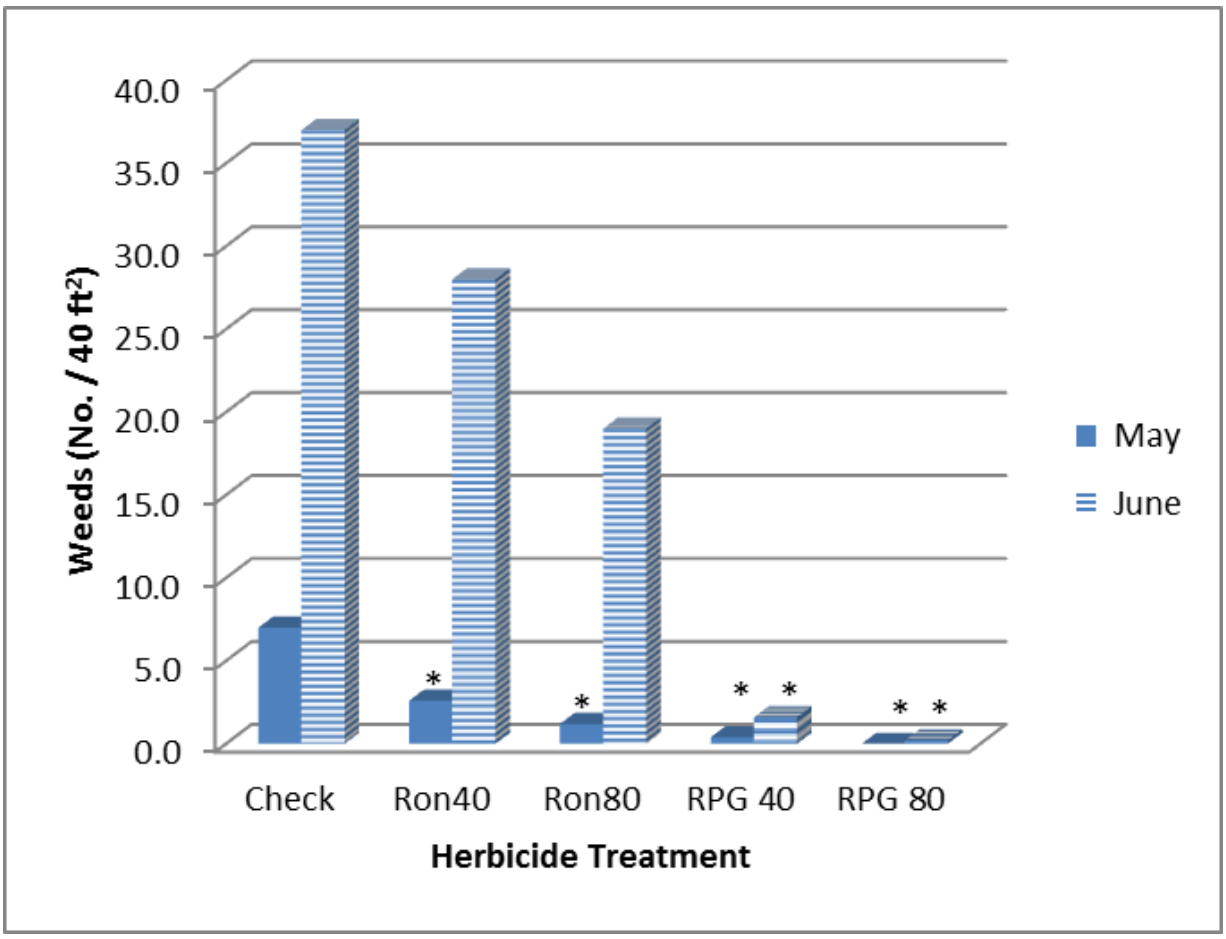

Figure 1. Herbicide weed control of loblolly pine seed beds with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Flint River Nursery in Byromville, GA 2013

Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

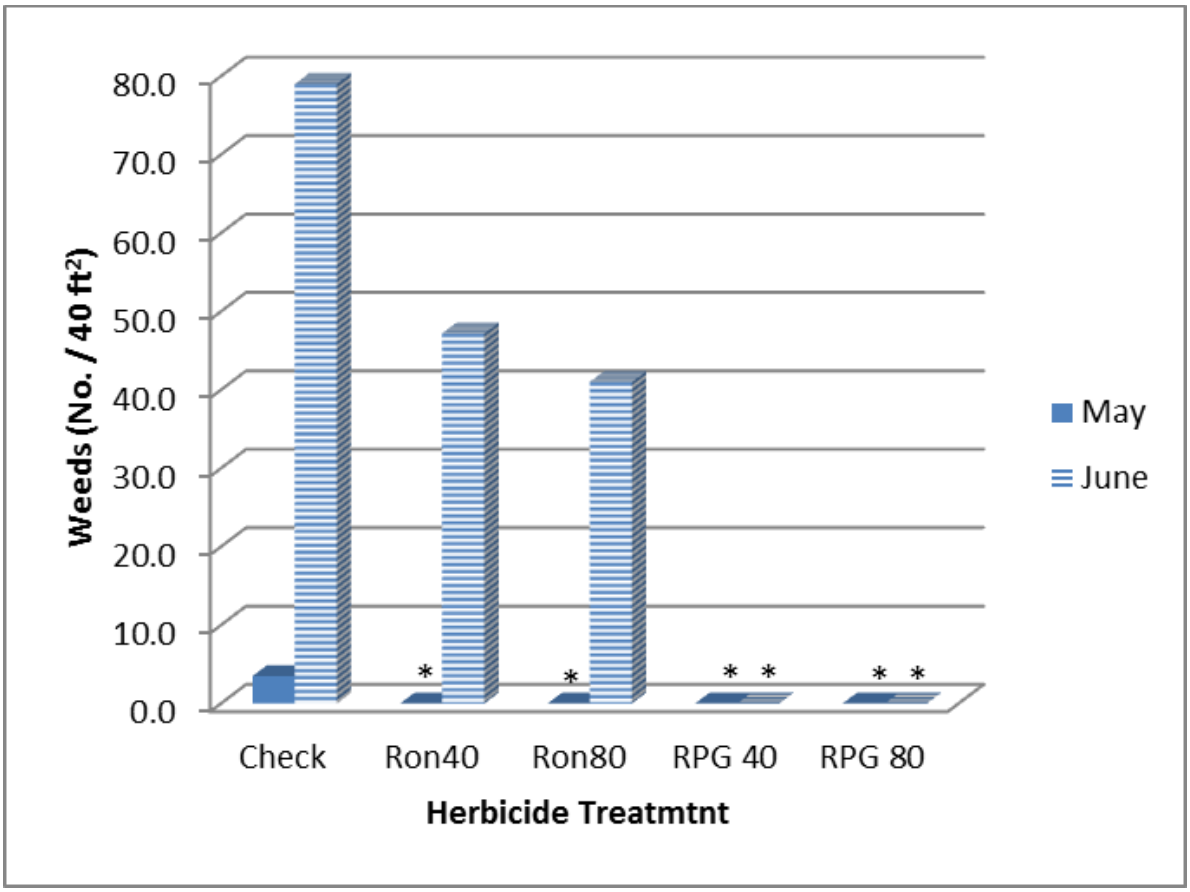

Figure 2. Herbicide weed control of loblolly pine seed beds with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Plum Creek Nursery in Jesup, GA 2013.

Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

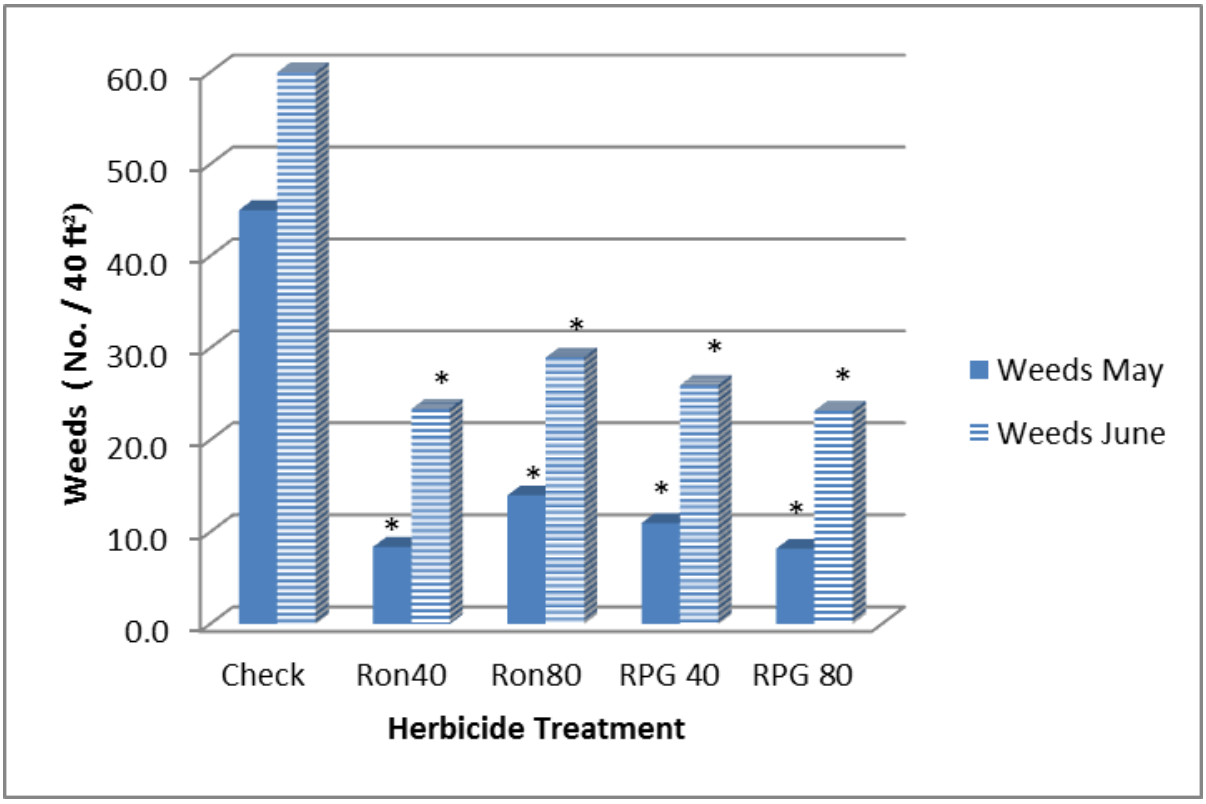

Figure 3. Herbicide weed control of loblolly pine seed beds with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Native Forest Nursery in Chatsworth, GA 2013.

Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

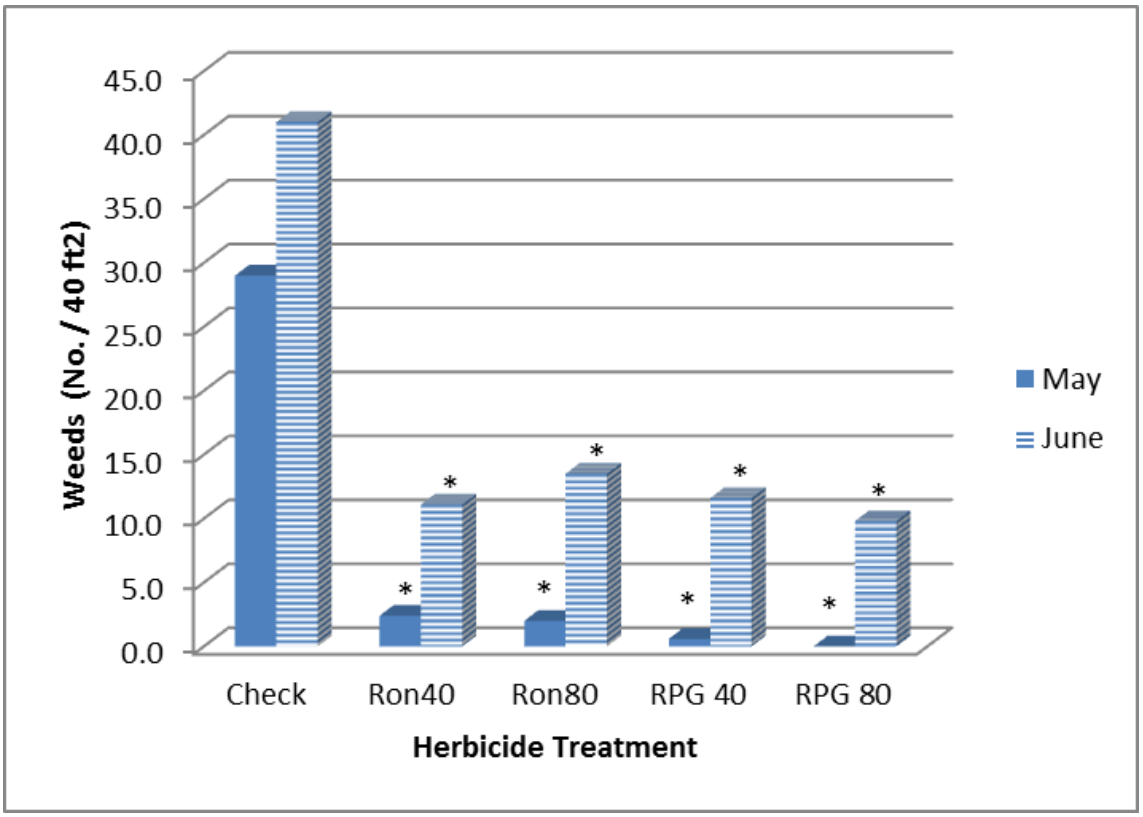

Figure 4. Herbicide weed control of loblolly pine seed beds with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Rayonier Nursery in Elberta, AL 2013.

Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

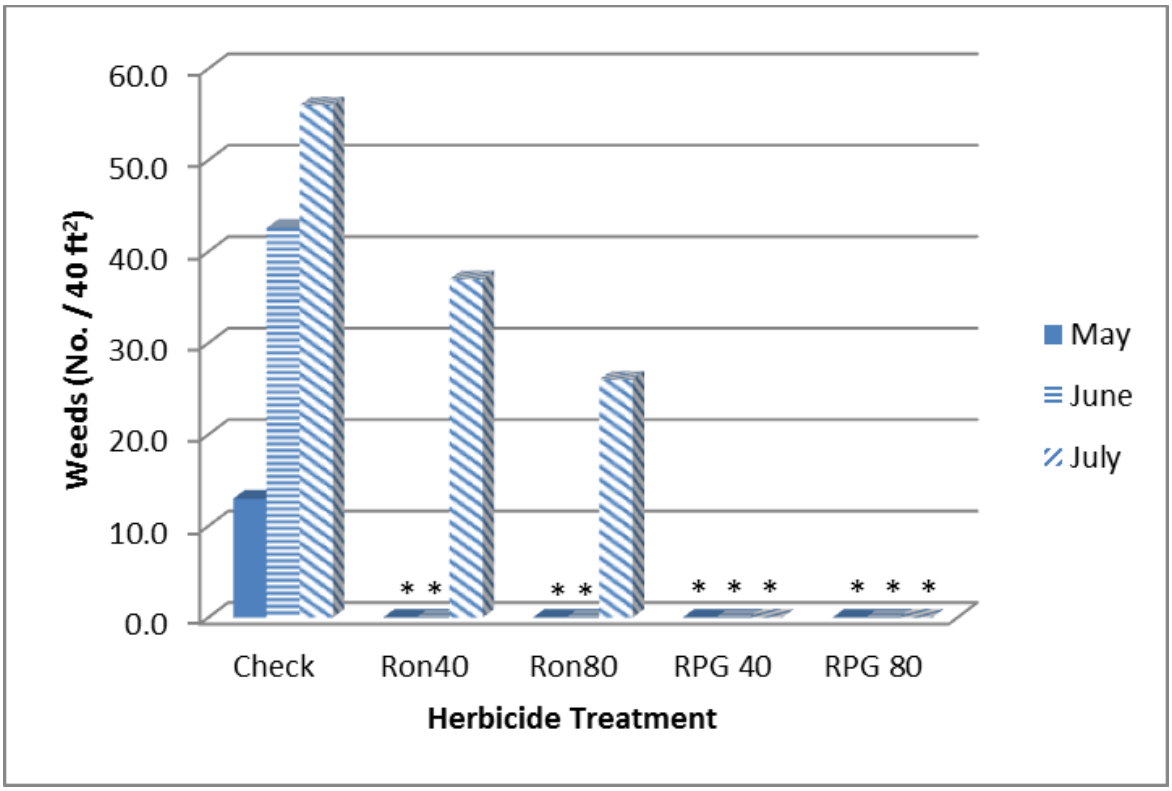

Figure 5. Herbicide weed control of loblolly pine seed beds with Ronstar Flo, alone and in combination with Pendulum AquaCap and Goal 2XL at the Pine Hill Nursery in Camden, AL 2013.

Means with an asterisk indicate significant difference of the herbicide treatment when compared to the Check treatment (no herbicide application) according to Dunnett's T-test, alpha=0.05. Ron40=Ronstar Flo @ 40 oz/ac, Ron80 = Ronstar Flo @ 80 oz/ac, RPG 40 = a tank mix of Ronstar Flo @ 40 oz/ac, Pendulum AquaCap at 34 oz/ac and Goal 2XL @ 32 oz/ac, RPG 80 = a tank mix of Ronstar Flo @ 80 oz/ac, Pendulum AquaCap at 68 oz/ac and Goal 2XL at 64 oz/ac. All treatments applied at time of sowing.

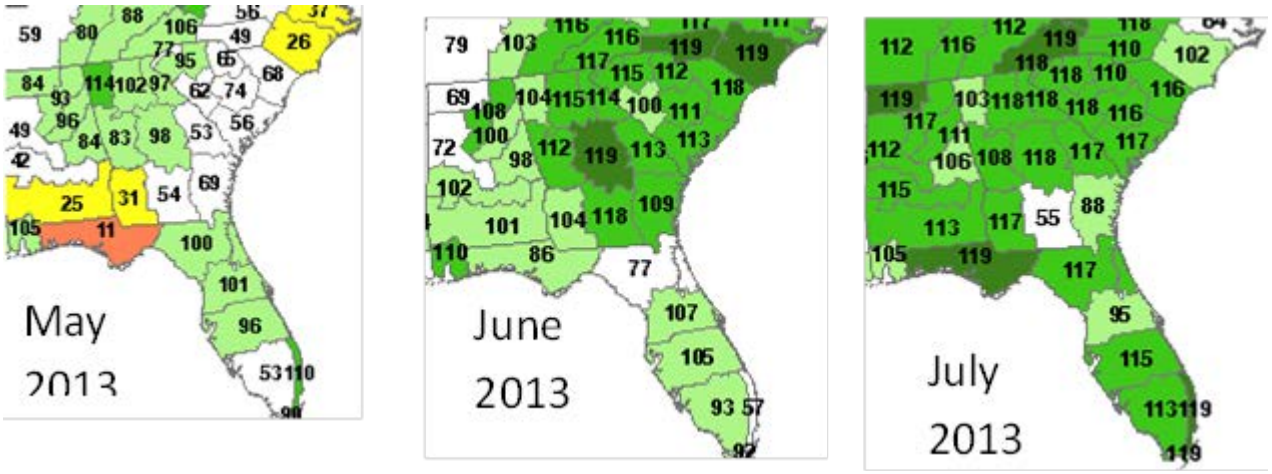

Figure 6. Rainfall patterns for the eastern United States for the months of May, June and July 2013.

Number is ranking out of 119 with respect to month and year. For example, of the past 119 June's the central part of Georgia was the 119 wettest on record.