INFLUENCE OF HARVEST DATE AND SILVICULTURAL PRACTICES ON THE ABUNDANCE AND IMPACT OF PINE REPRODUCTION WEEVILS IN WESTERN GULF LOBLOLLY PINE PLANTATIONS[1]

Donald M. Grosman, Ronald F. Billings, Frank A. McCook, and William W. Upton[2]

Abstract—Populations of the pales weevil (*Hylobius pales* (Herbst)) and pitch-eating weevil (*Pachylobius picivorus* (Germar)) and/or weevil-caused pine seedling mortality were monitored in the Western Gulf Region on 36 loblolly pine (*Pinus taeda* L.) plantation sites in 1997 and 26 sites in 1998. Data also were collected for 15 site parameters on each site. Pales weevils generally emerged first and numbers peaked in late March, whereas pitch-eating weevil numbers peaked later in mid-April. Weevil-caused pine seedling mortality averaged 9.5 percent in 1997 and 17.9 percent in 1998. Only pales weevil numbers in March showed significant correlations with subsequent weevil-caused seedling mortality in both 1997 and 1998. Of the 15 site parameters evaluated, harvest to April 1 interval and site preparation intensity appeared to have the most influence on the extent of weevil-caused seedling mortality. Seedling mortality from weevils increased dramatically on sites harvested after October of the previous year, but decreased with increasing site preparation intensity.

INTRODUCTION

Pine reproduction weevils, primarily pales weevil, *Hylobius pales* (Herbst), and pitch-eating weevil, *Pachylobius picivorus* (Germar), are important pests of pine seedlings in the southern United States (Peirson 1921). Adult weevils, attracted to recently-harvested pine sites, feed on the bark and phloem of newly-planted pines, often completely girdling the seedlings. These weevils are capable of reducing first-year pine seedling survival by 40-90 percent (Thatcher 1960, Walstad and Nord 1975).

With increased cutting and replanting of pines in the South, concern has resurfaced over the accompanying increase in seedling losses due to reproduction weevils. Weevil-caused pine seedling mortality has been reported to be dependent on the period of the year that a site is harvested (Cade and others 1981, Doggett and others 1977). Damage can be reduced if planting is delayed for 8-12 months after cutting (Doggett and others 1977, Thatcher 1960). However, for economic reasons, delayed replanting is not acceptable to forest managers who generally observe a policy of promptly replanting after cutting.

There is wide variation in the occurrence of weevil activity on different sites. Foresters representing the Texas Forest Service and several forest industries with land holdings in the Western Gulf Region indicate that seedling mortality due to weevil feeding has been exceptionally light in Texas and Louisiana (personal communications with D.M.G.). However, the fact that survival of spring-planted seedlings is frequently not checked until late fall suggests that the actual seedling mortality due to weevil feeding in Texas and Louisiana may not be fully recognized. Seedlings which die early (spring or early summer) often shed their bark by fall, obscuring any signs of weevil damage. As a result, seedling mortality may be attributed to other factors, such as disease or drought.

In 1996, a study was conducted having the following objectives: 1) to determine the abundance and impact, if any, of reproduction weevils on pine seedling survival in the Western Gulf Region; 2) to determine if a correlation exists between numbers of weevils captured in pit traps and subsequent pine seedling mortality; and 3) to determine the extent to which different site parameters influence the impact of pine reproduction weevils on seedling survival.

SITES

The study was conducted in east Texas, west Louisiana, and southwest Arkansas. In 1996, 18 pine plantations, harvested between June and December, 1995, were selected in Harrison, Nacogdoches, Jasper, and Newton Counties, TX to monitor weevil populations. In 1997 and 1998, 36 pine plantations and 26 plantations, respectively, were selected to monitor weevil populations and/or evaluate the impact of weevils and other mortality factors on first-year pine seedling survival. Sites selected in 1997 were harvested between January, 1996 and March, 1997 and had been treated prior to planting with one of five commonly used site preparation methods (no site preparation (10), burn only (4), shear only (10), shear and bed (8), and 4 - shear and subsoil (4)). Plantations selected in 1998 were located in east Texas (north to Upshur Co., south to Hardin Co., east to Newton Co., and west to Walker Co.) and harvested between June, 1997 and March, 1998. Site preparations on these sites included 15 with no site preparation, 4 raked and piled, 2 sheared only, and 5 sheared and burned.

PROCEDURES

Three pit traps, as described by Rieske and Raffa (1991), were set up in each of 18 (in 1996), 10 (in 1997) and 9 (in 1998) plantation sites, all in east Texas, between January and March of a given year. A distance of at least two chains (132 ft) separated each trap. All traps contained fresh pine bolts and an insecticide strip and were baited with a 5:1 mix of ethanol and turpentine. Traps were reset every 2-8 weeks and captured weevils were collected and identified after 1 week.

Once each site was planted in 1997 and 1998, a survey of 100 marked pine seedlings (10 evenly spaced plots, each containing 10 flagged seedlings) was conducted monthly

[1] Paper presented at the Tenth Biennial Southern Silvicultural Research Conference, Shreveport, LA, February 16-18, 1999.

[2] Entomologist II, Assistant Department Head, Research Specialist, and Staff Forester II, Texas Forest Service, Forest Pest Control Section, Lufkin, TX 75902, respectively.

(March through November) in 1997 and three times (May, July, and November) in 1998 to determine the percent mortality attributed to weevils and other causes.

Data on various site parameters were collected for each site in 1997 and 1998 and included: 1) pine species composition prior to harvest, 2) pine basal area prior to harvest, 3) hardwood basal area prior to harvest, 4) harvest dates (or interval), 5) acres harvested, 6) acres clear cut or thinned within a 1 mile radius of the site, 7) site index at 25 years, 8) soil type, 9) volume of pine timber harvested per acre, 10) site preparation intensity (no site preparation, low, medium, or high), 11) site preparation date, 12) planting date, 13) duration of seedling storage, 14) type of planting (hand vs. machine), 15) stocking level of replant. Regression analysis was used to determine if a relationships existed between site parameters and weevil-caused pine seedling mortality and weevil trap catch and weevil-caused pine seedling mortality.

RESULTS AND DISCUSSION

Weevil Abundance

The seasonal abundance of pales weevil and pitch-eating weevil on sampled sites in the Western Gulf Region is shown in Figure 1A and 1B, respectively. Peak trap catch for both species was somewhat variable depending on the year. Generally, pales weevils emerged first in January, peaked between early and late March, and became scarce by June or July. In contrast, pitch-eating weevils began emerging in February, peaked in April or May, but then remained fairly abundant through August. The species ratio of total trap catch numbers was near 1:1 in 1996. However, by 1998, pales weevil numbers had more than doubled to about 15 weevils per trap per day and the species ratio had shifted to 2:1 in favor of pales. The progressively higher numbers of pales weevil captured in 1997 and 1998 may be attributed in part to two consecutive warm winters (1996/97 and 1997/98), which may have increased pales weevil larvae and adult survival compared to that of pitch-eating weevil.

Relation Between Weevil Abundance and Weevil-caused Seedling Mortality

Significant relationships were discovered in both March 1997 and March 1998 between the number of pales weevils captured in pit traps and the final percentage of weevil-caused seedling mortality on replanted sites (table 1). Other significant relationships also were discovered for pales and pitch-eating weevils in April, May and/or June. Unfortunately, no significant relationships were found in February when a trap-based monitoring tool would be most useful operationally to predict weevil damage later in the year.

Weevil Impact

In 1997, total pine seedling mortality on the 36 sites averaged 23.9 percent with a range of 0 to 71 percent. Weevils and improper planting were the major causes. Losses to weevils averaged 9.5 percent (range: 0 to 45 percent) while improper planting accounted for average losses of 5.4 percent (range: 0 to 41 percent) (fig. 2). One-fourth of the monitored sites had >20 percent weevil-caused pine seedling mortality. Other causes (combination of drought, flood, and unknown) accounted for an average loss of 8.9 percent. First-year loblolly pine seedling mortality in 1998 was considerably higher than in 1997. Total mortality on the 26 monitored sites averaged 71.1 percent with a range of 5 to 92 percent. Drought and weevils were the major causes of mortality, accounting for 33.1 percent

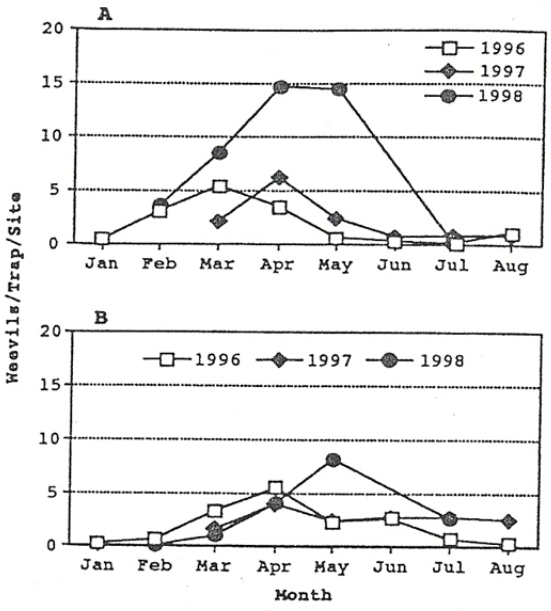

Figure 1—Seasonal abundance of A) pales and B) pitch-eating weevils captured in baited pit traps from 1996 through 1998.

Table 1—Relationships between the number of pales and pitch-eating weevils captured in pit traps and percent weevil-caused pine seedling mortality

	Pales		Pitch-eating	
Month	1997	1998	1997	1998
February	—	NS	—	—
March	*[a]	*	NS	NS
April	NS	*	NS	NS
May	NS	*	NS	*
June	NS	—	*	—
July	NS	NS	NS	NS
August	NS	—	NS	—

NS = not significant.
[a] = significant relation at the 5 percent level.

(range: 2 to 83 percent) and 21.6 percent (range: 0 to 65 percent), respectively (fig. 2). Forty-two percent of the sites had >20 percent weevil-caused pine seedling mortality. Other causes (combination of improper planting, disease, and unknown) accounted for an average loss of 14.1 percent.

Influence of Site Parameters on Impact of Weevils

Regression analysis revealed that only two site parameters (harvest to April 1 interval and site preparation intensity) that significantly influenced the extent of weevil-caused pine

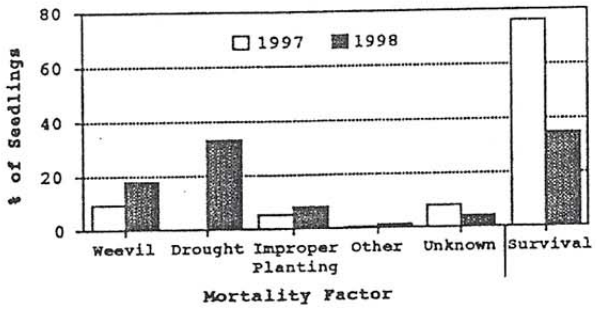

Figure 2—First-year loblolly pine mortality and survival on plantation sites in 1997 (N = 36) and 1998 (N = 26). Percent mortality by all factors plus survival equals 100 percent.

seedling mortality in the Western Gulf Region in both 1997 and 1998 (table 2). Both parameters appeared to equally influence weevil impact in a given year. However, each parameter explained less of the variability in weevil-caused seedling mortality in 1998 compared to 1997. The occurrence of a severe drought in 1998 may have reduced the influence of these two parameters on weevil-caused pine seedling mortality.

CONCLUSIONS

This study showed that pine reproduction weevils are abundant in the Western Gulf Region and can have a significant impact on first-year pine seedling survival. Nearly one-third of all sites monitored in 1997 and 1998 experienced >20 percent weevil-caused pine seedling mortality. Of 15 site parameters evaluated, harvest to April 1 interval and site preparation intensity appeared to most influence the level of weevil-caused pine seedling mortality. Based on the results of this study, graphs illustrating potential risk of weevil damage were developed (fig. 3A and 3B). Moderate to high seedling mortality (20 - 65 percent) due to weevils alone is likely on planted sites harvested the previous November through January and having no site preparation. Low to moderate mortality (0 - 30 percent) can be expected on sites harvested between August and October of the previous year, harvested in February and March of the replanting year, and having low to moderate intensity site preparation, i.e., rake, windrow, burn, or shear. Sites harvested between April and July of the previous year are at low risk (0 - 10 percent) to weevil damage. Essentially no damage is expected on sites harvested prior to April of the previous year or having high intensity site preparation, i.e., bedding or subsoil methods. (fig. 3B). However, caution needs to be taken when assessing the risk on sites harvested in February and March of the replanting year as only 3 sites were monitored in this study. Additional sites (not just those harvested in February or March) need to be monitored to strengthen the risk rating system for the Western Gulf Region.

The significant correlation between the number of pales weevil captured in pit traps in March and the percentage of weevil-caused pine seedling mortality suggests the possibility that monitoring weevil populations early in the spring may allow prediction of weevil damage later in the year. Additional trapping studies conducted in the fall of the previous year and early the following year (January - March) are needed to develop such a predictive tool.

Table 2—Relationships between 15 site parameters and percent weevil-caused pine seedling mortality in 1997 and 1998

	1997		1998	
Site parameter	r^2	P value	r^2	P value
Pine spp. composition prior to harvest	0.027	0.3388	0.014	0.5614
Pine basal area prior to harvest	.019	.4272	.027	.4363
Hardwood basal area prior to harvest	.170	.0125	.147	.0589
Harvest - April 1 interval	.368	.0001	.186	.0280
Acres harvested within site	.114	.0437	.000	.9184
Acres clear cut or thinned within 1 mile of site	.017	.4551	.174	.0959
Site index at 25 years	.008	.6124	.102	.1117
Soil type	.116	.0417	.013	.5738
Volume of pine harvested per acre	.099	.0616	.179	.0352
Site preparation intensity	.391	.0001	.218	.0161
Site preparation - April 1 interval	.312	.0004	.094	.1271
Planting date	.017	.4544	.000	.9332
Duration of seedling storage	.008	.6013	.005	.7680
Planting method (hand or machine)	.001	.8857	.143	.0566
Stocking level of replant	.003	.7491	.117	.0870

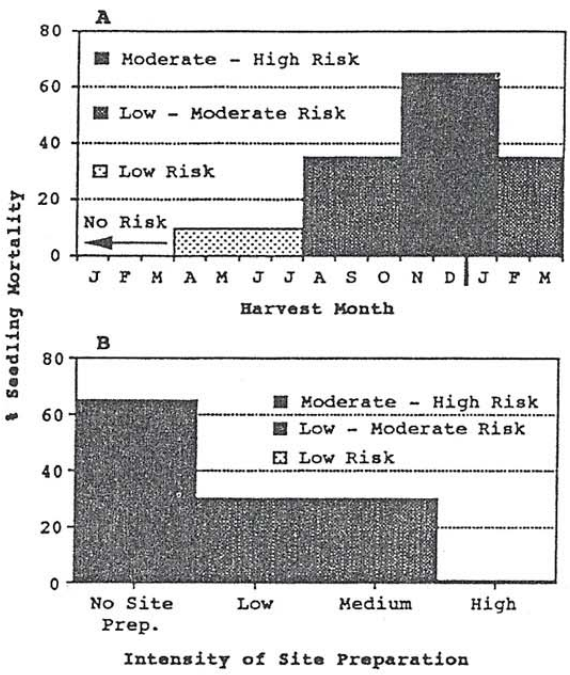

Figure 3—Risk of weevil-caused pine seedling mortality based on A) harvest date and B) site preparation intensity.

ACKNOWLEDGMENTS

The authors wish to thank the many foresters and technicians with the Texas Forest Service, Boise Cascade Corporation, Champion International Corporation, International Paper Company, and Temple-Inland Forest Products Corporation who provided research sites and participated in the surveys.

REFERENCES

Cade, S.C.; Lynch, A.M.; Hedden, R.L.; Walstad, J.D. 1981. Seedling debarking weevils: a site hazard-rating system case history. In: Hedden, R.L. [and others], eds. Hazard-rating systems in forest insect pest management. Gen. Tech. Rep. WO-27. U.S. Department of Agriculture, Forest Service: 27-30.

Doggett, C.; Grady, C.R.; Green, H.J. [and others]. 1977. Seedling debarking weevils in North Carolina. Res. Note 31. North Carolina Forest Service. 13 p.

Peirson, H.B. 1921 The life history and control of the pales weevil (*Hylobius pales*). For. Bull. 3. Peterham, MA: Harvard Forest. 33 p.

Rieske, L.K.; Raffa, K.F. 1991. Effects of varying ethanol and turpentine levels on attraction of two pine root weevil species, *Hylobius pales* and *Pachylobius picivorus* (Coleoptera: Curculionidae). Environmental Entomology. 20: 48-52.

Walstad, J.D.; Nord, J.C. 1975. Applied aspects of pales weevil control. Down to Earth. 31: 8-12.