TIP MOTH CONTROL AND LOBLOLLY PINE GROWTH IN INTENSIVE PINE CULTURE: FOUR YEAR RESULTS

David L. Kulhavy, Jimmie L. Yeiser, and L. Allen Smith[1]

Abstract—Twenty-two treatments replicated four times were applied to planted loblolly pine, *Pinus taeda* L., on bedded industrial forest land in east Texas for measurement of growth impact of Nantucket pine tip moth (NPTM), *Rhyacionia frustrana* Comstock, and effects on pine growth over 2 years. Treatments were combinations of Velpar®, Oust®, Escort®, and Arsenal® herbicides; and diammonium phosphate (DAP) fertilizer with treatments in 2000, in 2001, or in both years. Ten of the treatments were treated with Mimic timed with pheromone traps to reduce NPTM infestations. NPTM was controlled with the Mimic, and there was a small but significant increase in the loblolly pine growth at the end of the second growing season. However, the increase was mimimal by the end of the fourth growing season. The best growth of pines with the most intensive treatments was equal with and without NPTM control. NPTM control made a difference on intermediate treatments.

INTRODUCTION

The Nantucket pine tip moth (NPTM), *Rhyacionia frustrana* (Comstock), is an important pine regeneration insect in the eastern and southern United States (Berisford 1987), with larval feeding causing significant damage particularly in areas of forest regeneration (Yates and others 1981). Southeastern industrial forestry, to maximize production of wood and fiber, currently emphasizes establishment of large, homogeneous pine plantations that may favor increased damage by NPTM following vegetation control treatments (Ross and Berisford 1990). NPTM infestation rates tended to increase as site preparation intensity increased and levels of competing vegetation and overstory decrease (Berisford and Kulman 1967, Hertel and Benjamin 1977, Hood and others 1988, Lantagne and Burger 1988, Nowak and Berisford 2000, White and others 1984, Zutter and others 1986). Intensive forest management practices that improve tree growth, such as weed control and fertilization, have been shown to exacerbate NPTM damage and decrease volume growth (Cade and Hedden 1987, Fettig and others 2000, Ross and Berisford 1990, Ross and others 1990, Sun and others 1999). However, McCravy and Berisford (2001) showed significantly lower NPTM damage in plots with vegetation control than in untreated plots; and Nowak and others (2003) found NPTM populations to be unstable following applications of fertilizers and herbicides. Miller and Stephen (1983) indicated competing herbaceous and woody vegetation provide food and shelter for NPTM predators and parasites.

Pritchert and Smith (1972) observed little change in NPTM infestation on trees fertilized with nitrogen. Application of phosphorus, however, resulted in a significant NPTM reduction, with potassium reducing NPTM even further. Tiarks and Haywood (1985), in a study measuring effects of fertilization and vegetation control on loblolly pine, observed uniform NPTM damage across all treatments, but NPTM infestation rates were not quantified. Meeker and Kulhavy (1992) found a negative correlation between NPTM levels in soil and foliage and NPTM infestation rates, with increasing levels of phosphorus associated with decreasing infestation rates.

Herbicides, including Sulfometuron methyl (Oust®) and Hexazinone (Velpar®-L), are commonly used to reduce competing herbaceous vegetation in loblolly pine plantations (Cantrell and others 1985, Creighton and others 1986, Kulhavy and others 2004, Michael 1985, Yeiser and Boyd 1989, Yeiser and Rhodenbaugh 1994). Use of herbicides for vegetation management continues to increase (Dubois and others 1999) along with growth (Glover and others 1994); forest fertilization has increased, with 200,000 acres of southern pines fertilized at planting. The resulting population of NPTM following herbicide applications and fertilizers, especially addition of phosphorus, warrants additional investigation. Ross and others (1990) documented that percent infested trees and percent infested shoot tips were significantly higher in banded and broadcast-treated plots than in check plots during the third NPTM generation.

METHODS

Twenty-two six tree by six tree plots with a two row buffer were established on an Upper Coastal Plain industrial forest site with a fine sandy silt loam near Diboll, Angelina County, TX, in early 2000. The study was a complete randomized block with 22 treatments replicated 4 times. The area was site prepared with pre-emergent herbicides and deep plowed with loblolly pine planted on the ridges.

The 22 treatments are shown in table 1. Mimic was applied five times each season, timed to first instar larvae with pheromone traps. Mimic® 2LV Insecticide (active ingredient tebufenozide) (Rohm and Haas, ownership of the product changed to Dow AgroSciences LLC, June 1, 2001) was applied following label instructions on a per acre basis timed with pheromone traps baited with synthetic NPTM lures. Dr. Don Grosman, Forest Pest Management, Texas Forest Service, Lufkin, TX, provided NPTM trap catch data and advice on Mimic timing for application. NPTM infestations were counted on a whole tree basis after the third generation in 2000, at the end of the season (fifth generation overwintering in the tips), after the third generation in 2002, and at the end of the season (fifth generation). Infestations were counted on the (1) terminal (infested or not infested), (2) top whorl except for the top terminal, (3) top half of the tree, and (4) bottom half of the tree (Kulhavy and others 2004). Each tip was examined as

[1] Regents Professor and T. L. L. Temple Professor, respectively, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962; and Southern Pine Beetle Specialist, Texas Forest Service, Forest Pest Control, Lufkin, TX 75901.

Citation for proceedings: Connor, Kristina F., ed. 2006. Proceedings of the 13th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS–92. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 640 p.

Table 1—Herbicide and fertilizer treatments, 2000-2001

2000		2001	
Herbicide[a]	Fertilizer	Herbicide[a]	Fertilizer
	lbs. per acre[b]		*lbs. per acre[b]*
VO*			
VO*	125		
VO*	250		
VO/AO*	125		
VO/AO*	250		
VO*		AO	
VO*	125	AO	125
VO*	250	AO	
VO/AO		AO	
VO/AO*	125	AO	125
VO/AO*	250	AO	
CHECK			

[a] VO = Velpar (10.7 oz) + Oust (2 oz.); Escort® = ¾ oz.; AO = Arsenal (4 oz.) + Oust (2 oz.).
[b] DAP = diammonium phosphate; *Mimic = treatments replicated with and without Mimic; five applications of Mimic each season, 2000 and 2001 timed to the first instar larvae of the Nantucket pine tip moth with pheromone traps.

infested or uninfested. A total tree count was taken for the site for each of the treatments over the replications. Data were analyzed with SAS with an ANOVA using New Duncan's Multiple Range Test at p=0.05 (SAS 1988).

RESULTS AND DISCUSSION

There was no difference in survival for year 4 between the Mimic and non-Mimic treatments, with 85.4 percent survival for both treatments. There were no differences in survival among any treatments. There was 86.3 percent survival of Mimic and non-Mimic treatments in year 2.

Height in feet was not significantly greater for Mimic treatments in year 4; height averaged 19.32 feet for Mimic treatments and 18.32 feet for non-Mimic treatments. Among non-Mimic treatments, heights were equal between VO 250 (year 1) + AO (year 2), 18.99 feet; VO 125 (year 1) + AO 125 (year 2), 19.0 feet; VO/AO 125 (year 1) + AO 125 (year 2), 19.21 feet; and VO/AO 250 (year 1) and AO (year 2), 19.46 feet. These treatments were significantly greater than VO (year 1), 17.05 feet; and both were greater than the check (16.03 feet). For Mimic treatments, VO 125 (year 1) + AO 125 (year 2) was 19.85 feet, and VO/AO 250 (year 1) and AO (year 2) were 20.20 feet. Both were greater than VO (year 1, 18.01) and the check (16.03 feet). The VO was greater than the check for Mimic treatments.

Mimic-treated plots combined were significantly greater in year 4, 24.1 cubic feet volume compared to 21.3 for non-Mimic treatments. The only difference between treatments occurred between Velpar-Oust (year 1 treatment) + Arsenal-Oust (year 2 treatment) with the Mimic-treated plots with 24.0 cubic foot volume and the non-Mimic treatments with 20.5 cubic foot volume (table 2). Ground line diameter (inches) was not significantly greater in Mimic treatments by year 4 (4.7 inches Mimic, 4.5 inches non-Mimic).

Table 2—Volume Index (cubic feet) for loblolly pine (year 4), following control of Nantucket pine tip moth with Mimic, years 1 and 2

Treatments[a]				Volume index	
2000		2001		Mimic	Mimic
Herbicide	Fertilizer	Herbicide	Fertilizer	No	Yes
				- - cubic ft[b] - -	
VO				16.1	19.6
VO	125			20.4	20.9
VO	250			21.7	21.4
VO/AO	125			23.1	23.8
VO/AO	250			21.7	23.2
VO		AO		20.5a	24.0b
VO	125	AO	125	23.8	28.3
VO	250	AO		23.9	28.3
VO/AO		AO		20.9	
VO/AO	125	AO	125	25.2	26.6
VO/AO	250	AO		25.6	26.5
CHECK				13.2	
Mean				21.3a	24.1b

[a] Refer to table 1 for treatments.
[b] Means with letters are significantly different between columns, $p < 0.05$; means without letters are not significantly different.

At the end of year 2, for non-Mimic treatments, NPTM infestations were significantly higher on the check plots [(10.46 infested tips) versus VO + 125 pounds DAP (9.7 infested tips); VO + AO + 125 pounds DAP (2000) (9.5 infested tips); and VO + AO (2000) and AO (2001) (9.32 infested tips)] compared to all other treatments. The lowest infestations were on VO + 250 pounds DAP (2000) and AO (2001) (5.19 infested tips) and VO (2000) and AO (2001) (5.65 infested tips). Intermediate infestations ranged from 7.07 to 8.42 infested tips. NPTM infestations were not taken in year 4 due to the height of the sample trees.

During a year of low to moderate NPTM infestations (2001), the most intensive cultural treatments had similar volume growth with or without Mimic for NPTM control. For Mimic applications, NPTM infestations were intermediate at the end of year 2 with intermediate treatments [VO + 125 pounds DAP (2000) and AO + 125 pounds DAP (2001); and VO + 250 pounds DAP (2000) and AO (2001)] (Kulhavy and others 2004).

SUMMARY

For 2001, a year of low to moderate NPTM infestations, the most intensive cultural treatments showed no difference in cubic feet volume growth with or without Mimic. For intermediate cultural treatments, Mimic applications had a significant increase in tree volume. The timing of spraying coupled with the cost of the insecticide and the labor for application need to be considered in long-term intensive management of industrial pine plantations. At the end of year 4, the only differences were in overall volume growth between Mimic and non-Mimic plots; differences among treatments occurred between VO + 250 pounds DAP (year 1) + AO (year 2). This indicates the use of Mimic, especially for low to moderate treatments, may not have a lasting effect on overall growth. Differences did occur among treatments, but these mainly reflected the intensity of the site preparation and increased fertilization rather that NPTM control. Timing and frequency of Mimic applications need to be examined in years of high NPTM infestations.

LITERATURE CITED

Berisford, C.W. 1987. The Nantucket pine tip moth. Chapter 6. In: Berryman, A.A., ed. Forest insect outbreaks: patterns, causes and management strategies. New York: Plenum Publishing Company: 141-161.

Berisford, C.W.; Kulman, H.M. 1967. Infestation rates and damage by the Nantucket pine tip moth in six loblolly pine categories. Forest Science. 13: 428-438.

Cade, S.C.; Hedden, R.L. 1987. Growth impact of pine tip moth on loblolly pine plantations in Arkansas. Southern Journal of Applied Forestry. 11: 128-133.

Cantrell, R.L.; Minogue, P.J.; Metcalfe, C.S.; Zutter, B.R. 1985. Silvicultural herbicide uses. In: Cantrell, R.L., ed. A guide to silvicultural herbicide use in the Southeastern United States. Auburn, AL: Auburn University: 1-14.

Creighton, H.L.; Glover, G.R.; Zutter, B.R. 1986. Loblolly pine growth response to herbaceous weed control—a summary of 15 studies. Proceedings of the Southern Weed Science Society. 39: 193.

Dubois, M.R.; McNabb, K.; Straka, T.J. 1999. Costs and cost trends for forestry practices in the South. Forest Landowner. 58(2): 3-8.

Fettig, C.J.; Dulusky, M.J.; Bersiford, C.W. 2000. Nantucket pine tip moth phenology and timing of insecticide spray applications in seven Southeastern States. Res. Pap. SRS-18. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 21 p.

Glover, G.R.; Quicke, H.E.; Lauer, D.K. 1994. Economics of early vegetation control in southern pine forests. Southern Weed Science Proceedings. 47: 83-84.

Hertel, G.D.; Benjamin, D.M. 1977. Intensity of site preparation influences on pine webworm and tipmoth infestations on pine seedlings in north central Florida. Environmental Entomology. 6: 118-122.

Hood, W.M.; Hedden, R.L.; Berisford, C.W. 1988. Hazard rating forest sites for pine tip moth, *Rhyacionia* spp. in the upper Piedmont Plateau. Forest Science. 34: 1083-1093.

Kulhavy, D.L.; Yeiser, J.L.; Smith, L.A. 2004. Nantucket pine tip moth control and loblolly pine growth in intensive pine culture: two-year results. In: Connor, K.F., ed. Proceedings of the 12th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS-71. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 147-149.

Lantagne, D.O.; Burger, J.A. 1988. Effects of site preparation intensity on the early growth of loblolly pine (*Pinus taeda* L.) and the incidence of pine tip moth (*Rhyacionia* spp.). New Forests. 2: 219-229.

McCravy, K.M.; Berisford, C.W. 2001. Effects of vegetation control on parasitoids of the Nantucket pine tip moth, *Rhyacionia frustrana* (Lepidoptera: Tortricidae). Florida Entomologist. 84: 282-287.

Meeker, J.R.; Kulhavy, D.L. 1992. Pine tip moth (Lepidoptera: Tortricidae) infestation rates as influenced by site and stand characteristics in loblolly pine plantations in east Texas. Environmental Entomologist. 21: 534-541.

Michael, J.L. 1985. Growth of loblolly pine treated with Hexazinone, sulfometuron methyl and metsulfuron methyl for herbaceous weed control. Southern Journal of Applied Forestry. 9: 20-26.

Miller, F.D., Jr.; Stephen, F.M. 1983. Effects of competing vegetation on Nantucket pine tip moth (Lepidoptera: Tortricidae) populations in loblolly pine plantations in Arkansas. Environmental Entomology. 12: 101-105.

Nowak, J.T.; Berisford, C.W. 2000. Effects of intensive management practices on insect infestation levels and loblolly pine growth. Journal of Economic Entomology. 93: 336-341.

Nowak, J.T.; Harrington, T.B.; Berisford, C.W. 2003. Nantucket pine tip moth development and population dynamics: influence of nitrogen fertilization and vegetation control. Forest Science. 49: 731-737.

Pritchert, W.L.; Smith, W.H. 1972. Fertilizer response in young pine plantations. Soil Science Society of America Proceedings. 36(4): 660-663.

Ross, D.W.; Berisford, C.W. 1990. Nantucket pine tip moth response to water and nutrient status of loblolly pine. Forest Science. 36: 719-733.

Ross, D.W.; Bersiford, C.W.; Godbee, J.F., Jr. 1990. Pine tip moth, *Rhyacionia* spp., response to herbaceous vegetation control in an intensively site-prepared loblolly pine plantation. Forest Science. 36: 1105-1118.

SAS Institute Inc. 1988. SAS/STAT user's guide. Cary, NC: SAS Institute Inc. 1028 p.

Sun, J.H.; Kulhavy, D.L.; Roques, A. 1999. Effects of fertilizer and herbicide applications on Nantucket pine tip moth infestation (Lep., Tortricidae). Journal of Applied Entomology. 124: 191-195.

Tiarks, A.E.; Haywood, J.D. 1985. *Pinus taeda* L. response to fertilization, herbaceous plant control, and woody plant control. Forest Ecology and Management. 14: 103-112.

White, M.N.; Kulhavy, D.L.; Conner, R.N. 1984. Nantucket pine tip moth (Lepidoptera: Tortricidae) infestation related to site and stand characteristics in Nacogdoches County, Texas. Environmental Entomology. 13: 1598-1601.

Yates, H.O.; Overgaard, N.A.; Koerber, T.W. 1981. Nantucket pine tip moth. Insect and Disease Leaflet 70. Washington, DC: U.S. Department of Agriculture, Forest Service. 7 p.

Yeiser, J.L.; Boyd, J.M. 1989. Control of competitors yields two-year seedlings response. Proceedings of the Southern Weed Science Society. 42: 191-188.

Yeiser, J.L.; Rhodenbaugh, E.J. 1994. Early survival and growth of loblolly pine seedlings treated with sulfometuron or Hexazinone plus Sulfometuron in southwest Arkansas. Tree Planters' Notes. 45: 116-120.

Zutter, B.R.; Glover, G.R.; Gerstad, D.H. 1986. Effects of herbaceous weed control using herbicides on a young loblolly pine plantation. Forest Science. 32: 882-899.