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Site/stand factors influencing Nantucket pine tip moth in loblolly pine plantations

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SITE/STAND FACTORS INFLUENCING NANTUCKET PINE TIP MOTH IN LOBLOLLY PINE PLANTATION?

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Abstract. -- Tip moth infestation and loblolly pine growth were examined on sandy, loamy and clayey sites in 2-3 year old plantations. Infestations were greatest on loamy sites. Following fertilizer and herbicide applications, tip moth infestations were lowest on fertilized plots following application of phosphorus.

INTRODUCTION

Pine tip moths, particularly the Nantucket pine tip,moth, Rhyacionia frustrana, are important insect pests of young pines in the southeastern United States, central California and part of New Mexico. Damage caused by tip moths causes loss in height growth, stem deformation, loss in wood quality, bushy appearance, and in severe instances, tree mortality (Yates et al. 1981). Forestry trends, in an effort to maximize fiber and timber production, have resulted in the establishment of increasing acres of pine plantations. These plantations are susceptible to tip moths during early growth (ages 1-5) and populations of tip moths and numbers of damaged tips vary according to site/stand factors and tree species. In the southeastern United States, loblolly (Pinus taeda) and shortleaf pine (P. echinata) are the favored hosts.

Generally, the more suitable the host trees are to the site, the less severe the damage (Wakeley 1928, Yates 1960). Intensive vegetation management often results in increased tip moth infestation rates. Phosphorus fertilizers tended to reduce tip moth infestations while increased nitrogen did not (Pritchett and Smith 1972).

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In Texas, site preparation intensity, site index, tree age, tree height, depth of the soil A horizon times the soil texture (from sand to clay) and soil texture at 61 centimeters, were significant factors in classifying plantations as either low or high hazard to tip moths (White et al. 1984). In South Carolina, Hood (1986) found site intensity preparation, site index, depth to A horizon and soil calcium significant variables for predicting tip moth infestations.

This paper reports on tip moth infestation and host tree growth related to cultural treatments and contrasting soil types (sand, silt, clay) in East Texas.

METHODS AND MATERIALS

Typic Quartsipsamments (fine sand)

Study plots were established in January 1983 on Typic Quartzipsamments (Tonkawa series), 10 km. west of Garrison, Nacogdoches County, Texas. Seven treatments were established of four replicates of 48 seedlings each, at 2.5 m x 2.5 m spacing, with a similar buffer between replicates. The treatments include:

1. bare-rooted loblolly pine (LP);
2. Terra-Sorb treated LP;
3. clay-slurry treated LP;
4. bare-rooted slash pine (SP);
5. Terra-Sorb treated SP;
6. clay-slurry SP; and
7. containerized longleaf.

Details of plot layout, four year survival and soil texture are presented in Kroll et al. (1985) and Kulhavy et al. (1987).

Aquic Paleudult (fine sandy loam)

On an Aquic Paleudult, (Kullit series), tip moth infestation rates were investigated following treatments of fertilizers and herbicides on a two-year old loblolly pine plantation. Four treatments in a randomized block design with four replicates on 0.2 hectare plots were applied as follows:

1. control (no treatment);
2. fertilizer (ammonium nitrate, 34-o-0, applied at a rate of 660 Kg/ha; 225 Kg/ha N; and concentrated superphosphate (0-46-O) at a rate of 280 Kg/ha; 56 Kg/ha P);
3. herbicide (hexazinone, 420 **gm/ha;** and sulfumeturon methyl, 210 **gm/ha);**
4. fertilizer + herbicide (treatments **2+3).**

Fertilizers were applied by hand with measured amounts evenly distributed within a 0.5 m radius around each tree. Herbicides were applied by a boom sprayer following label instructions. Tip moth infestation rates, height, diameter and volume (ht. x dia^2) were measured at the end of the 1987 growing season and analyzed using one-way analysis of variance and Duncan's multiple range test.

Tip Moth Infestation Rates on Contrasting Soil Types.

Tip moth infestation rates were measured on fine sand (Typic Quartzipsamments), loamy fine sand (Plinthic Paleudults) and a very fine sandy loam over a clay (Vertic Hapludalfs) over two seasons (1985-1986). Infestation rates were related to tree and soil nutrition, soil and tree moisture and tree growth characteristics. Infestation rates were measured on 25 trees over three plots on three to four year old loblolly pine plantations in Nacogdoches and Angelina Counties. Details of sampling procedures are outlined in Meeker (1987).

RESULTS AND DISCUSSION

Typic Quartzipsamments

Six year survival is reported in Table 1. The decline in survival from 1984-1986 was due to drought during the summer seasons. Tip moths and town ants (Atta **texana)** were not currently present on the site. Height and diameter-measurements of loblolly pine indicated significantly taller trees for clay slurry compared to Terra-Sorb treated and untreated trees; and significantly larger diameter for clay slurry compared to Terra-Sorb treated trees. Volumes were also significantly larger for clay slurry trees (Table 2). Computing a survival volume index (percent survival x height x diameter') indicated no difference between clay-slurry (0.74) and Terra-sorb **(0.70),** but both had a greater volume index than control (0.26).

Conclusions are that Terra-sorb treated trees had greater survival, but currently, clay slurry and Terra-sorb treated trees both occupy the same growing volume. Additional monitoring is required to examine the long-term height and diameter growth.

Table 1.--Percent survival of loblolly, slash and **longleaf** pine, on Typic Quartzipsamments, six year results.

Treatment	October 1983	1984	1985	1986	1988
Longleaf Pine	85.2	56.5	56.0	56.0	54.0
Loblolly **(Terra-Sorb[R])**	81.3	50.8	46.5	40.1	38.0
Loblolly (Clay Slurry)	49.2	31.9	31.3	29.12	28.0
Loblolly (Untreated)	50.5	19.6	21.3	21.3	14.0
Slash **(Terra-Sorb[R])**	46.9	20.8	16.2	14.6	14.0
Slash (Clay Slurry)	35.4	16.9	12.0	10.4	10.0
Slash (Untreated)	41.4	16.9	23.5	14.1	10.0

Table 2.--Height, diameter and survival volume index of loblolly pine, on Typic Quartxipsamments, six year results.

Treatment	Height (mean ± SD)	Diameter (mean ± SD)	Survival Volume Index
	m	**cm**	
Control	**3.09±0.85a**[1]	**7.8±2.2ab**	0.26
Terra-Sorb	**3.56±0.98b**	**7.2±2.4a**	0.70
Clay Slurry	**3.93±1.04c**	**8.2±2.3b**	0.74

[1] Means followed by same letter not significantly different at P = 0.05 using Duncan's multiple range test.

Table 3.--Mean percent NPTM infestation rates, Aquic Paleudult **(Kullit** series), Nacogdoches County, Texas, 1987.

Treatment	Number of Trees Measured	Mean Infestation
		percent
Control	76	**10.21b**[1] ± 9.0 S.D.
Fertilizer (56 Kg/ha P + 225 Kg/ha **N)**	77	**6.28a** ± 7.3 S.D.
Herbicide (420 gmfha hexazinone and 210 **gm/ha** sulfumeturon methyl)	76	**10.12b** ± 9.4 S.D.
Fert. + Herb.	77	**9.73b ±** 9.7 S.D.

[1] Means followed by same letter not significantly different at P = 0.05 using Duncan's Multiple Range Test.

Table 4.u-Mean height and diameter measurements in centimeters (cm) following fertilizer and herbicide applications, loblolly pine plantation, Aquic Paleudult (Kullit series), Nacogdochee County, Texas, 1987.

Treatment	Pre-Season Height March, 1987	Post-season Height October, 1987	Mean Growth	March Dia.	Oct. Dia.	Mean Growth
	cm	cm	cm	cm	cm	cm
Control	50.7	111.6a[1]	60.89a	1.47	2.13a	0.64a
Fertilizer (56 Kg/ha P + 225 Kg/ha N)	55.5	124.71,	69.2b	1.65	2.31ab	0.66ab
Herbicide (420 gm/ha hexasinone and 210 gm/ha sulfumeturon methyl)	50.5	109.0a	59.0a	1.55	2.36ab	0.81b
Fert. + Herb.	55.6	128.0b	72.4b	1.55	2.59b	1.04c

[1] Means followed by same letter not significantly different at P = 0.05 using Duncan's Multiple Range Test.

Fertilizer/Herbicide Treatments

NPTM infestation rates were calculated on a whole tree basis as the ratio of apparently infested tips to total tips. Infestation rates at the end of the 1987 growing season were homogeneous with the exception of those receiving fertilizer, which were significantly lower (Table 3). Reasons for this effect are unclear, but host vigor enhancement may increase overall resistance by increasing resin production, which is the trees' major physiological defense against NPTM larvae. The increased competing vegetation following fertilization may also have provided improved habitat for NPTM predators and parasites, and, in some cases, hindered access to trees by ovipositing females, This may partially explain the apparent negation of the fertilizer effect by the addition of herbicide (Table 3).

Height growth was significantly greater on plots receiving fertilizer and fertilizer plus herbicide, while diameter growth was best on fertilizer plus herbicide and herbicide treatments (Table 4). The fertilizer treatments, while stimulating height growth, also stimulated competing vegetation. This had little effect on height growth, but restricted diameter growth. Herbicide treatments, in suppressing competing vegetation , allowed for greater diameter growth.

Tip Moth Infestation Rates on Contrasting Soil Types

Individual tree measurements and site/stand factors indicated lower tip moth populations with increased levels of phosphorus in both the foliage and upper 15 cm of the soil on all three sites. The higher the silt content in the soil, the larger the tip moth populations. In 1986, measurement of tree moisture content indicated higher infestation rates with lower moisture stress. The three soil types examined produced three contrasting systems of host type and corresponding levels of tip moth infestation. The sandy soil had the lowest nutrient levels and soil moisture leading to thin branches and low tip moth populations. The clayey site had the highest nutrition levels and soil moisture content and moderate infestations in 1985 and low in 1986. The loamy site, with the highest percentage of silt, had moderate nutrient levels and soil moisture. Periodic rains resulted in hosts of moderate heights and diameters. Tip moth infestation rates were the highest on this site for both 1985 and 1986.

Poor growth of host trees corresponded to low infestation rates. Moderate growth of host trees corresponded to the highest infestation rates. Vigorous growth corresponded to moderate to low infestation rates, (a highly desirable host is produced, but success of attacks is limited).

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