Effects of Loblolly Pine Establishment Intensity on Pine Growth, White-tailed Deer Carrying Capacity, and Northern Bobwhite Winter Food Index

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Newly established pine plantations provide critical early successional habitat which produces forage for white-tailed deer and northern bobwhite. Wildlife biologists have been concerned that increased stand establishment intensity may negatively impact habitat for these two culturally and economically important species. Mechanical site preparation in southern pines has been shown to provide a pulse of forage plants during the first 3 years following application, followed by a period of decline until crown closure. Investigations of chemical treatments have generally shown that herbicide use delays development of these plants. To address this issue, we studied the effects of 5 levels of stand establishment intensity on pine growth, nutritional carrying capacity for white-tailed deer, and winter forage production for northern bobwhite on commercial pine plantations in southern Mississippi for 4 years following establishment.

METHODS

The study was conducted on 4 commercial loblolly pine plantations in the Mississippi Lower Coastal Plain (LCP). All stands were planted on a 3.0 × 2.1 m spacing and fertilized with 280 kg/ha di-ammonium phosphate. Treatments combinations were designed by a consensus of cooperating industry foresters and the principal investigators to reflect the range of operational establishment intensities in current use. Treatments were combinations of site preparation and chemical release (Table 1). Mechanical site preparation consisted of a triple plow to subsoil, disk, and bed following a shear blade to remove debris. Chemical site preparation used a tank mix of Chopper® (2.4 L/ha), Accord® (3.5 L/ha®), and Garlon 4® (3.5 L/ha); chemical release consisted of banded or broadcast application of 0.9 kg/ha of Oustar®. Each treatment was applied to an area ≥ 8 ha within each stand for a randomized complete block design.

Table 1. Treatment combinations and designations applied to 4 commercial pine stands arranged from least intensive (M-Ba) to most (MC-Br2).

	Site Preparation		Release	
Treatment	Mechanical	Chemical	Banded	Broadcast
M-Ba	X		Year 1	
C-Ba		X	Year 1	
MC-Ba	X	X	Year 1	
MC-Br	X	X		Year 1
MC-Br2	X	X		Years 1 & 2

Pine height and ground line diameter were measured in Years 1-2 in permanent, 70-tree plots. Height and diameter at breast height (DBH) were measured in Years 3-4 in 5 permanent 1/40th-acre plots. Preferred deer forage plants were sampled from 20 1-m^2 exclosures per experimental unit in July of each year. Samples of each forage species were dried and weighed;

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this data was used to calculate the annual production of dry weight biomass for all preferred species within each experimental unit. Crude protein (CP) analysis was performed for each species. We calculated growing season carrying capacity at both 6% and 14% CP to reflect dietary requirements for maintenance and lactation, respectively. Winter forage plants for bobwhite were surveyed each June on 10 30-m line transects per experimental unit. We calculated and compared both coverage of preferred plants and a winter food suitability index (WFSI), which incorporated both plant coverage and accessibility. We analyzed results using a mixed model ANOVA, followed by means separation using a protected Fisher's LSD. Tree measurements from Years 1-2 and 3-4 were analyzed separately.

RESULTS

Pine height and diameter expressed treatment effects ($P<0.05$) in Years 2-4, and were positively correlated with treatment intensity. Intensity was directly reflected in pine growth response, with the exception of C-Ba, the only treatment without mechanical site preparation. The addition of mechanical site preparation (MC-Ba) significantly increased DBH, indicating the importance of mechanical site preparation for improved tree growth in this region. By year 4, MC-Br2 yielded 34% greater height and 40% greater diameter than C-Ba (Table 2).

Table 2. Mean height (m) and DBH (mm) in Year 4 of loblolly pine trees subjected to 5 levels of establishment intensity in the Mississippi LCP.

Treatment	M-Ba	C-Ba	MC-Ba	MC-Br	MC-Br2
Height	4.7 AB*	4.4 A	4.9 AB	5.3 BC	5.9 C
DBH	67 AB	63 A	75 BC	79 CD	88 D

* - Means within rows followed by the same letter are not significantly different ($\alpha=0.05$).

Nutritional carrying capacity estimates for white-tailed deer at the maintenance level (6% CP) exhibited both year and treatment effects ($P<0.05$, Table 3). Forage development was lower in Year 1 than in subsequent years, similar to the results of other studies adding herbicide use to mechanical site preparation. Estimates for lactation level (14% CP) carrying capacity were more complex, showing a Year × Treatment effect, with treatment differences observed in Years 1-3. C-Ba exhibited the highest carrying capacity in Year 1 (32 deer-days/ha), MC-Ba in Year 2 (27 deer-days/ha), and MC-Br in Year 3 (28 deer-days/ha), indicating that increasing management intensity increasingly delayed development of highly nutritious forage plants.

Table 3. Mean maintenance-level (6% CP) deer carrying capacity of 1–4-year-old pine plantations subjected to 5 levels of establishment intensity in the Mississippi LCP.

Treatment	M-Ba	C-Ba	MC-Ba	MC-Br	MC-Br2
Deer-days/ha	429 A*	303 AB	334 AB	217 BC	159 C

* - Means within rows followed by the same letter are not significantly different ($\alpha=0.05$).

Coverage of preferred quail food plants differed in Years 2-4 ($P<0.05$), within which M-Ba consistently exhibited the highest coverage (54-75%), MC-Br2 the lowest (5-32%). Coverage increased from Year 1 to Year 2 ($P<0.05$) for all treatments except MC-Br2, which did not increase until Year 3. The WFSI differed only in Year 1 ($P<0.05$), when broadcast chemical release eliminated nearly all quail food plants in MC-Br and MC-Br2, causing them to group below the other treatments. The index was similar among treatments in years 2 – 4, but for differing reasons: high-intensity treatment yielded less food plant coverage but greater accessibility than low-intensity treatments. WSFI of the 3 lower intensity treatments was consistent across years, but increased from Year 1 to Years 2-4 for MC-Br and MC-Br2 ($P<0.05$). Overall, high-intensity treatment delayed the development of foraging habitat for bobwhite compared with less intensive treatment.

DISCUSSION AND MANAGEMENT RECOMMENDATIONS

Treatments represented real changes in management intensity, with treatment-related differences in all measured variables. Herbicide use generally reduced the amount of forage available in the first year for both deer and quail, with broadcast release having a greater impact than banded. However, tree growth did not respond significantly to a single broadcast versus single banded release (MC-Br vs. MC-Ba). We therefore recommend avoiding broadcast chemical release in favor of banded for the sake of lessening the overall impact on forage production.

Deer in pine-dominated landscapes may rely on young plantations to supply a larger portion of their growing season nutrition than deer in agricultural systems. The nutrient poor soils of the Mississippi LCP further limit the availability of highly nutritious forage during a time of year when gestation, lactation, and antler growth place high demands on diet quality. Consequently, we suggest managing for better nutrition, if necessary trading some maintenance level carrying capacity for lactation level. While C-Ba provided the greatest lactation level carrying capacity and was not different from the highest maintenance level carrying capacity, the relatively poor tree growth response makes it less appealing. MC-Ba also showed well at both nutrition levels, avoided the problems associated with broadcast release, and provided good tree growth. We believe it is the optimal choice for managing both deer and timber.

Winter quail forage plants were also impacted by herbicide use. While greater accessibility allowed MC-Br and MC-Br2 to compete with the less intensive treatments after Year 1, broadcast release suppressed early succession plants important to quail and prevented MC-Br and MC-Br2 from providing winter foraging habitat in Year 1. We recommend avoiding broadcast release when managing young plantations for quail. In addition, soil disturbance is especially useful for creation of early succession areas important to quail. However, each of our treatments involved applying herbaceous control measures to the very area receiving the greatest soil disturbance within the stand (i.e., the beds). The WFSI measurements were moderate at best during a period otherwise noted in the literature for excellent response. We believe that altering the mechanical site preparation by using a shear blade and disk 1m wider than the bed, combined with banded release carefully applied to the bedded area only, would boost response of early succession plants and benefit quail without requiring additional visits to the stand. We recommend the MC-Ba treatment as the optimal choice for both quail and timber, especially if modified with a wider shear blade and disk.