

Understory Biomass Response to Microsite and Age of Bedded Slash Pine Plantations

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Abstract

Understory standing crop biomass was studied on three culturally imposed microsites (bed, furrow, and flat) bedded slash pine (*Pinus elliottii*) plantations in north Florida. Biomass was clipped in the late spring of 1977 on plantations 2, 5, and 10 years old and separated into five classes: grass, forb, sedge, shrub, and litter (including standing dead). After an initial abundance following site preparation, sedges and forbs dropped to relatively low levels within the first 5 years of plantations development. Grasses were the dominant live vegetation in two-year-old plantations. Shrubs became dominant by the fifth year and remained so through the 10th year. Litter, as a result of the lack of cultural treatments designed to remove accumulated dead vegetation, was the major biomass class (more than 8,000 kg/ha by the fifth year following pine establishment). Total live understory biomass increased from the second to the fifth year after which it decreased. Grass standing crop biomass was highest on the flats, lowest in furrows. Hence, forage inventories should be stratified by microsite. Prescribed burning on a properly managed cattle operation may prevent high accumulations of litter while effectively improving the availability of palatable forage. Forage may also be increased by decreasing the proportion of land occupied by the less productive microsites, namely the furrows and beds.

Forest management in the Atlantic and Gulf Coastal Plains relies heavily on mechanical site preparation (e.g., chopping, disking, and bedding) and artificial regeneration for successful establishment and rapid growth of pines (Worst 1964; Wilhite and Harrington 1965; McMinn 1969; and Harris et al. 1974). Bedding (Fig. 1) disturbs the soil and litter more than most other site preparation techniques, and it creates three distinct microsites: (1) *bed* or tree row; (2) *furrow* created by the bedding plow; and (3) *flat* midway between tree rows (White 1975). The furrow is most altered. The bedding plow removes top soil and leaves a relatively infertile subsoil. The bed is also highly disturbed, with organic matter and nutrients from the furrow concentrated on this microsite (Schultz 1976). The microsite midway between tree rows is little disturbed by bedding and closely represents the conditions of the site before bedding.

Bedding not only changes the microtopography from flat to undulating (Schultz and Wilhite 1975), but also brings about a vegetational response reflecting the different conditions of the three microsites (White 1975). The purpose of this study was to assess the differences in understory biomass among these culturally imposed microsites in bedded slash pine (*Pinus elliottii*) plantations of various ages near Gainesville, Florida.

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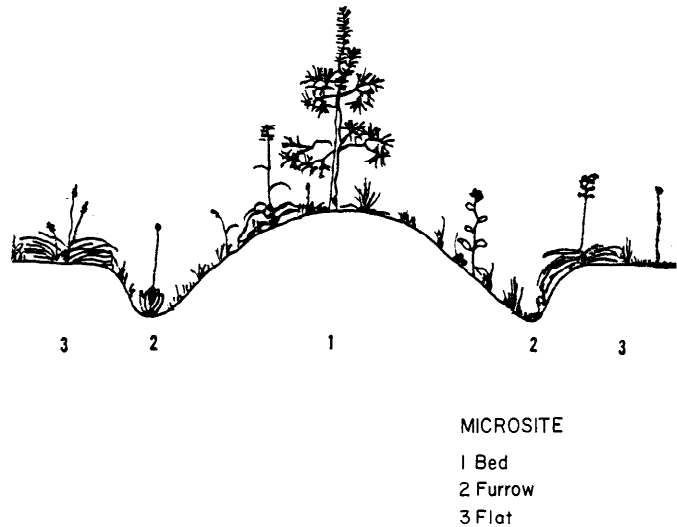


Fig. 1. Three culturally imposed microsites created by bedding. Adapted from White, 1975.

Study Areas and Methods

Study plots were located in bedded slash pine plantations 2-, 5-, and 10-years old (from time of planting), approximately 10 km west of Starke, Bradford County, Florida. Soils are sandy, siliceous, thermic family of *Ultic Hapaluquods* of the Mascotte series. The climate is subtropical and humid, with a frost free season of approximately 276 days and average annual precipitation of 130 cm (USDA 1954). During the month of sampling, rainfall in Starke (closest weather station to the sites) was 10.2 cm. Average high and low temperatures for the month of June are 26° and 19° C, respectively (Mitchell 1977).

Site preparation following clearcutting consisted of chopping, burning, and bedding, and was completed during the summer preceding the winter of planting. Beds were oriented nearly north and south—allowing each microsite to receive the same potential amount of sunlight. Sites were machine planted with 1,544 trees per hectare. No post planting cultural treatments (such as burning, grazing, or fertilization) were imposed. Site index at age 25 years is approximately 20 m for all plots.

Two replicate plantations of each age were chosen. A 15-meter zone around the perimeter of each plantation was excluded to avoid edge effects. Three 30 × 30 meter plots were randomly selected in each plantation. Plot borders were oriented parallel and perpendicular to bedding direction. Five transects were randomly selected within each plot for biomass sampling. Transects were 0.5 meters wide and extended from the middle of the bed across the furrow to the middle of the flat (Fig. 1). Understory biomass was harvested between May 25 and June 30, 1977. We estimate that vegetation present during this period represents approximately 1/3 of the potential yearly production.

Vegetation was harvested by microsite and separated into five

biomass classes: (1) grasses, (2) forbs, (3) sedges, (4) shrubs, and (5) litter [all dead, fallen biomass and standing dead understory biomass]. Grasses, forbs and sedges rooted within the transect were clipped to ground level. Shrub biomass rooted within or overhanging the transect was clipped to ground level. One additional biomass class, (6) total live understory, was constructed in analysis as the sum of grass, forb, sedge, and shrub biomass. Harvested vegetation was oven dried and expressed in kg/ha for each microsite. Mean values for each biomass class within each age were determined for each microsite. To account for the difference in size and productivity of microsites, these mean biomass class values were weighted (by percentage area occupied by microsite) to arrive at a weighted mean biomass value for each age.

A general linear model, as described by Steel and Torrie (1960), was fitted to test microsite effects on biomass classes for each plantation age using the Statistical Analysis System (SAS) on the NERDC computer AMDAHL 470 (Barr et al. 1976). Significant differences ($P < .05$) were evaluated using Duncan's new multiple range test.

Results

Grass Biomass

Grasses are the most important cattle forage in Coastal Plain pinelands. Weighted mean grass biomass was 2,190 kg/ha (Fig. 2) in the 2-year old plantations studied and was the dominant live biomass class. This represents a large increase in grass standing crop biomass over undisturbed sites in the short period of time, and provides a large potential forage resource not now utilized. Beckwith (1964) reported a marked increase in forage two years after site preparation on a Florida sandhill site.

The flat and bed microsites produced significantly more grass biomass than the furrow in the 2-year-old plantations (Fig. 3).

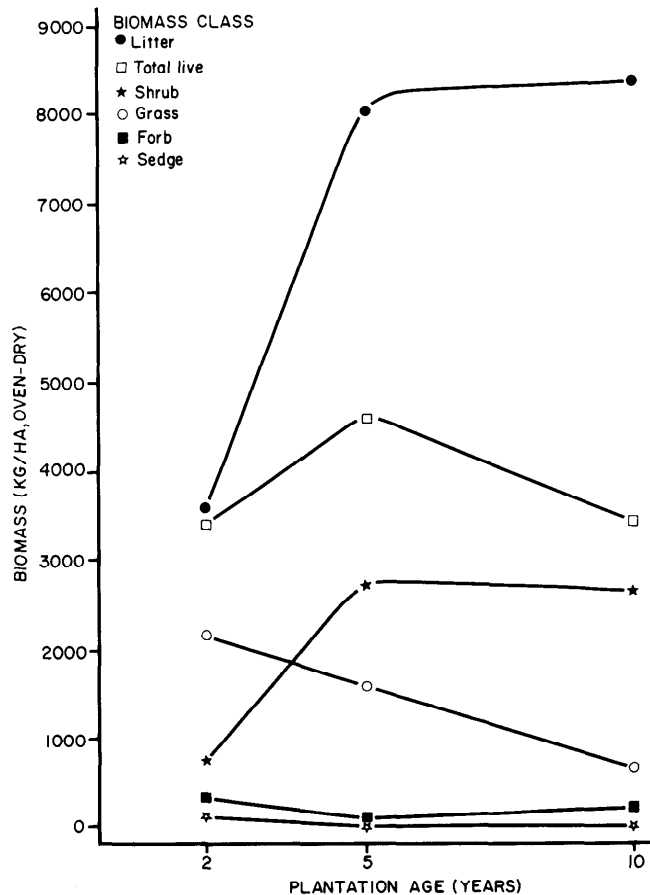


Fig. 2. Relationship of live plant standing crop to age of bedded slash pine plantations in north Florida.

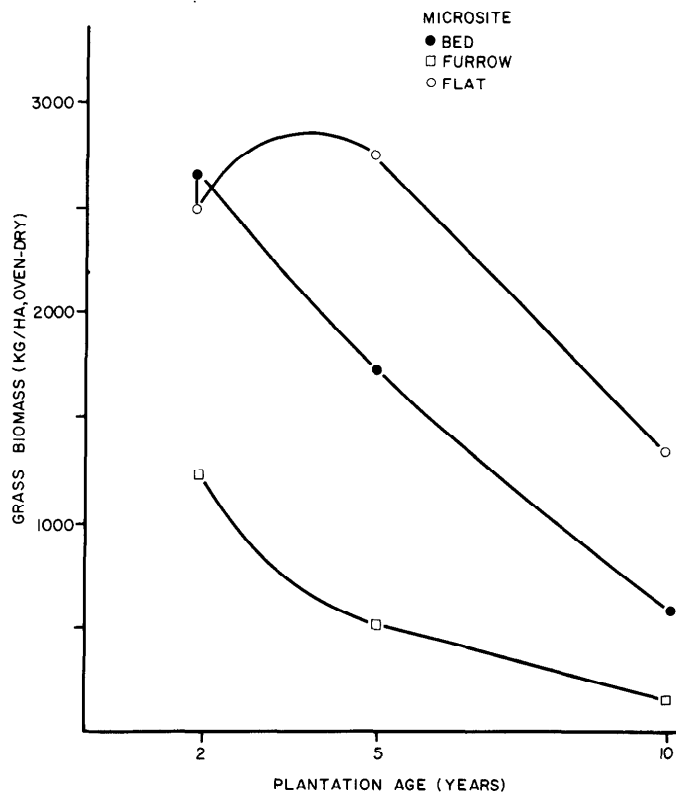


Fig. 3. Microsite effect on live grass biomass in bedded slash pine plantations of different ages in north Florida. (Microsite means connected by a vertical line were not significantly ($P < .05$) different.)

Microsite differences were all significant at 5 and 10 years of age, that is, the flats produced more grass than the beds, and the beds more than the furrows in older plantations.

Weighted mean grass biomass appeared to follow a linear decreasing function, from 2,187 kg/ha to 686 kg/ha by the 10th year (Fig. 2). This decrease in grass standing crop biomass with plantation development has been documented by several other researchers. Major grass species noted were chalky bluestem (*Andropogon capillipes*), broomsedge bluestem (*Andropogon virginicus*), and Florida dropseed (*Sporobolus floridanus*). Also abundant were needleleaf panicum (*Panicum aciculare*), narrowleaf panicum (*Panicum angustifolium*), Webber panicum (*Panicum webberianum*), and fringed leaf paspalum (*Paspalum ciliatifolium*).

Forb Biomass

Forbs are often good invader species that respond favorably to soil disturbance. The second growing season after plantation establishment, weighted mean forb biomass was 334 kg/ha (Fig. 2). Other researchers (White 1975; Schultz and Willhite 1975; Harris et al. 1974; and Hebb 1971) have reported temporary increases in forb biomass after similar site disturbances. In the 2-year-old plantations, beds produced significantly more forb biomass than the other microsites (Fig. 4). White (1974) found the furrow produced the most forb biomass followed by the bed and flat microsites, respectively. White's study was conducted on a poorly drained and very wet site in west Florida. Our study site is drier. Moreover, the mechanical action of the bedding plow on the Mascotte soils of the present study removed the more fertile A₁ horizon, leaving a relatively infertile A₂ horizon in the furrow microsite. This may explain the lack of robust forb invasion in this microsite, thereby leaving beds as the major early forb producer. Major forb species observed were Maryland meadowbeauty (*Rhexia mariana*), grassleaf goldaster (*Heterotheca graminifolia*), whitescale eupatorium (*Eupatorium leucolepis*), blackroot (*Pterocaulon pycnostachyum*), littleheaded goldenrod (*Solidago*

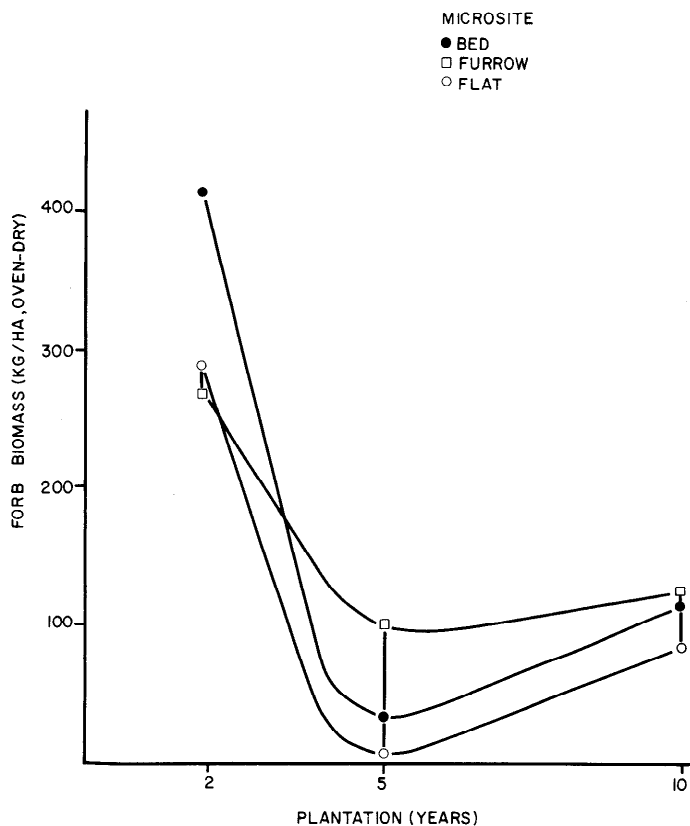


Fig. 4. Microsite effect on live forb biomass in bedded slash pine plantations of different ages in north Florida. (Microsite means connected by a vertical line were not significantly ($P < .05$) different.)

microcephala), and pennywort (*Centella asiatica*).

Sedge Biomass

Sedges contribute less to understory biomass than other vegetation classes studied. This was probably due to sedges being excluded by more efficient grass and forb invader species. Sedge biomass decreased with plantation age (Fig. 2) from a maximum of 117 kg/ha in the two-year-old plantations to a low of 0.42 kg/ha by age 10. No significant differences among microsites were found (Fig. 5). This result disagrees with other studies (Bennett 1965; White 1975) that showed wet site species, namely sedges, tended to be stratified by microsite and have most biomass in the wetter furrows. White (1977) found moderate site disturbance increased sedge production over no disturbance and intense disturbance. Sedge biomass on our plots was highest on the least-disturbed microsites, although not significantly so. We observed four sedge species: maidenhair sedge (*Eleocharis albidia*), netted nutrush (*Scleria reticularis*), common breakrush (*Rhynchospora fascicularis*), and breakrush (*Rhynchospora* spp.).

Shrub Biomass

Shrubs contributed more biomass in the older age plantations than other classes of vegetation. Weighted mean biomass was only 733 kg/ha in 2-year-old plantations, but amounted to over 2,700 kg/ha by age five (Fig. 2). White (1975) and Hebb (1977) reported shrubs were slow to return to their original frequencies after site preparation. Flat microsites contained significantly greater shrub biomass than the furrows and beds during early years (Fig. 6). This agrees with Schultz and Wilhite (1975) and White (1974) where they found shrub biomass to decrease with intensity of site preparation. There was an apparent stabilization of shrub biomass from the 5th to 10th year on all microsites (Fig. 6). Major shrub species were common gallberry (*Ilex glabra*), saw-palmetto (*Serenoa repens*), Southern waxmyrtle (*Myrica cerifera*), blackberry (*Rubus* spp.), ground blueberry (*Vaccinium myrsinites*), staggerbush

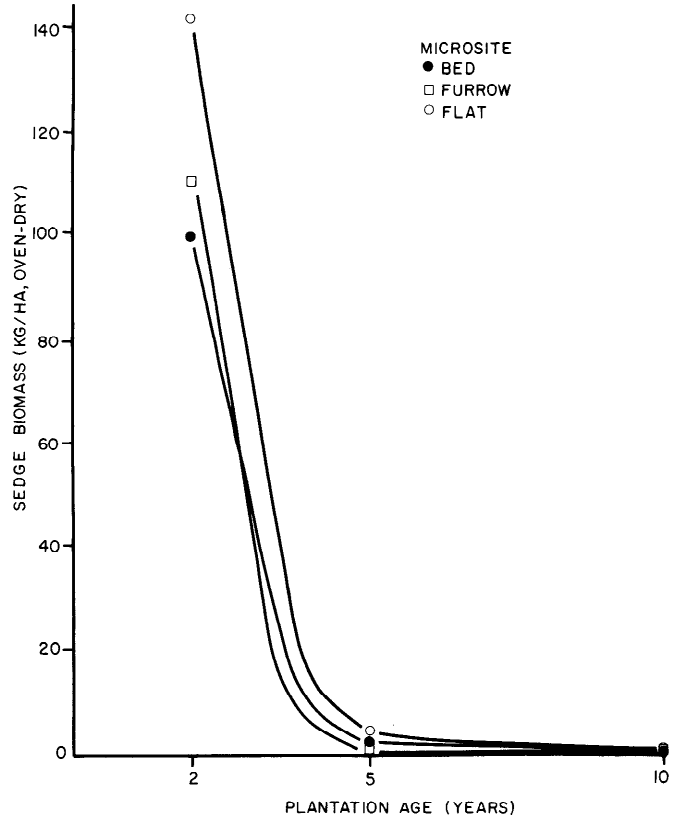


Fig. 5. Microsite effect on live sedge biomass in bedded slash pine plantations of different ages in north Florida. (No two microsite means at the same age were significantly ($P < .05$) different.)

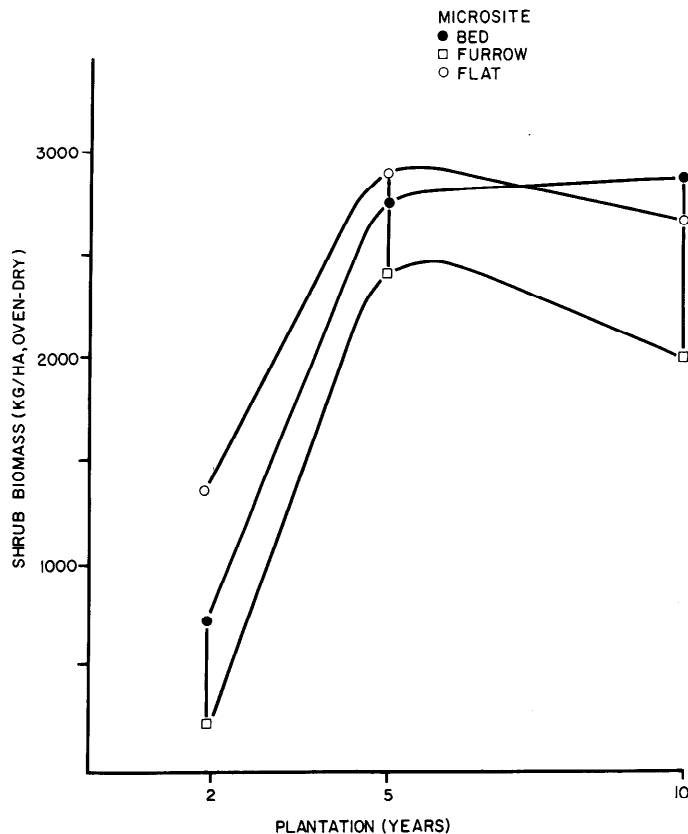


Fig. 6. Microsite effect on live shrub biomass in bedded slash pine plantations of different ages in north Florida. (Microsite means connected by a vertical line were not significantly ($P < .05$) different.)

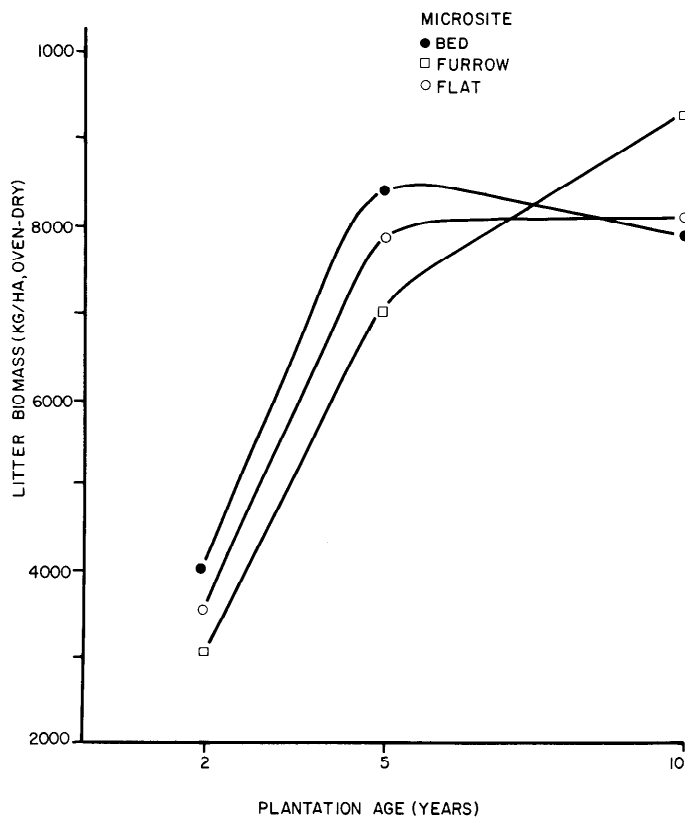


Fig. 7. Microsite effect on litter biomass (including standing dead) in bedded slash pine plantations of different ages in north Florida. (No two microsite means at the same age were significantly ($P < .05$) different.)

(*Lyonia ferruginea*), and sticky laurel (*Kalmia hirsuta*).

Litter Biomass

Litter accounted for a greater amount of biomass than all other understory vegetation combined (Fig. 2). This was due to a lack of cultural treatments designed to remove accumulated dead vegetation, such as prescribed burning or cattle grazing. Weighted mean litter biomass for the 2-year-old plantations was 3,605 kg/ha and over twice that value for the 5- and 10-year-old plantations (Fig 2). These high litter accumulations, mainly due to the abundant bluestems, create a significant wildfire hazard. Significant differences were not detected in litter accumulation among microsites in any of the plantations (Fig. 7).

Total Live Understory Biomass

Total live understory averaged 3,410 kg/ha for 2-year-old plantations (Fig. 2). This represented a large increase in understory standing crop biomass from nearly bare ground at the time of site preparation. The maximum total live understory standing crop (4,400 kg/ha (Fig. 2)) occurred at age 5 years and averaged approximately 1,000 kg/ha less at age 10 years. Beds produced a significantly larger amount of total live understory biomass than furrows in 2-year-old plantations, while flats had a significantly greater standing crop than furrows in all plantations (Fig. 8).

Discussion and Conclusions

Litter dominated the plantations classes studied, amounting to over 8,000 kg/ha by the fifth year. This accumulation in the younger plantations may be attributed to abundant bluestems (a preferred cattle forage). White (1975) and Schultz and Wilhite (1975) also found high litter accumulation associated with abundant bluestems in pine plantations. Besides constituting a serious wildfire hazard, litter buildup suppresses the amount of forage available (Beckwith 1964) and may immobilize nutrients needed

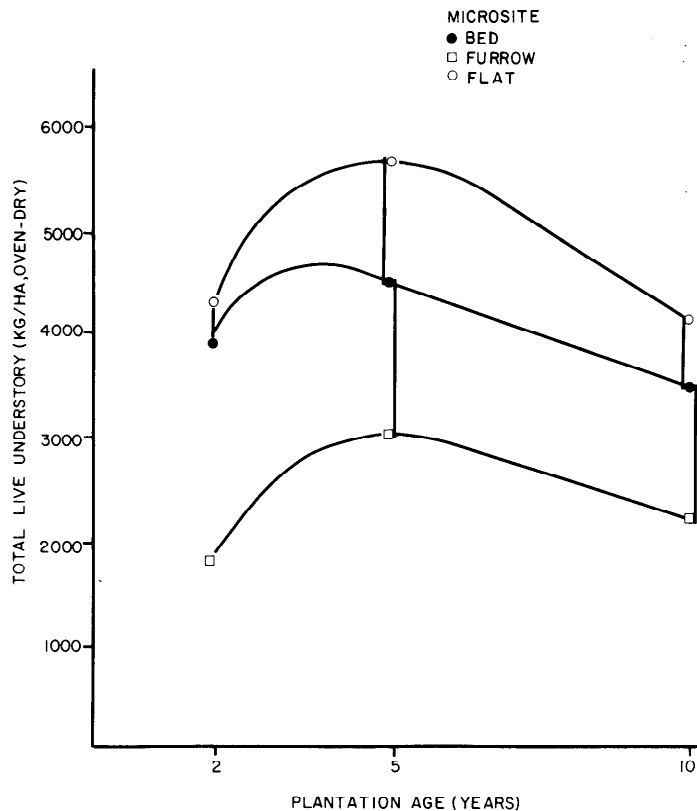


Fig. 8. Microsite effect on total live understory biomass in bedded slash pine plantations of different ages in north Florida. (Microsite means connected by the same vertical line were not significantly ($P < .05$) different.)

for vegetation growth. Prescribed burning or a properly managed cattle operation may prevent these high accumulations of litter, reduce the risk of wildfire, improve the availability of palatable forage, and extend forage production further into the plantations rotation cycle.

Grasses were the major biomass class in the 2-year-old plantations with a maximum of 2,698 kg/ha recorded for the bed. Cultural land treatments associated with current forestry operations for the north Florida area have promoted the more desirable range plant species. These species have increased to a point where an excellent seed source is available in many areas allowing quick recovery to produce good range forages following site preparation. Hence, there is a tremendous potential on this land for a profitable timber-range operation if properly managed.

Many of the biomass differences which seemed large were not statistically significant. This is attributed to the low sampling intensity on these highly diverse, inherently variable, flatwoods sites. It is suspected during early stages of plantation development that microsite vegetation may be highly related to soil moisture. Also, it is suspected that shrubs may inhibit herbage production more than the pines in developing plantations. Further study is needed in these areas.

The grass biomass class was the plant group most affected by microsite differences. Hence, in bedded plantations, understory forage inventories should be stratified according to the approximate proportion each microsite occupies of the total area. Forage may be increased in bedded plantations by increasing the proportion of land occupied by the more productive flat and bed microsites while maintaining the same tree densities. This can be accomplished by increasing spacing between tree rows, and decreasing tree spacing within rows.

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