Pot Culture—An Aid to Site Evaluation

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Most hardwood plantings on old fields in southern Indiana and adjacent areas have failed. In order to find the reasons for this failure, a way was sought to evaluate the effects of various soil factors on seedling growth. Such factors as soil structure, organic matter content, and microorganism populations can be measured, but the relative effects of individual or combined factors are difficult to determine because no common denominator is available. The problem was to find a way to manipulate these various soil characteristics under controlled conditions so that their influence on seedling growth could be determined.

Methods

To get this job done large cores of undisturbed soil were collected in gallon cans. These cans then served as pots for growing seedlings. Salvaged number 10 tin cans which are about 6 inches in diameter and 7 inches high were used. To take a sample the open top of the can was pressed firmly against the soil surface and the litter cut by tracing the outline of the can with a trowel or knife. The can was driven flush to the surface with a sledge hammer and a 2-inch-thick block of wood (fig. 1). A small hole punched in the can bottom allowed the air to escape. The can was dug from the ground with a shovel and the excess soil shaved off the core bottom with a trowel. The best time for taking samples was when the soil was moist, near field capacity. Stones, roots, and very tight soil caused some loss of cans. In a forest soil practically free of stone, about half of the cans were ruined because of roots. When the cores were ready for treatment and planting the can bottoms were removed with a can opener leaving the undisturbed soil core enclosed in a tin sleeve.

To find out if the cores taken as described would produce differential growth responses in tree seedlings, two trial runs were made. Cores were taken in Zanesville silt loam on a broad ridge under four different cover types: (1) an old field, (2) a 22-year-old shortleaf pine (*Pinus echinata* Mill.) plantation, (3) a 22-year-old black locust (*Robinia pseudoacacia* L.) plantation, and (4) a second-growth, mixed-hardwood stand. The old field and plantations were originally parts of the same abandoned field. The plantations and the forest stand were well stocked with complete crown closure, while the old field contained a sparse cover of weeds and grass.

Soil cores from some of the sites were broken up and sieved through a 2-mm. screen to destroy macrostructure. Another series of cores was

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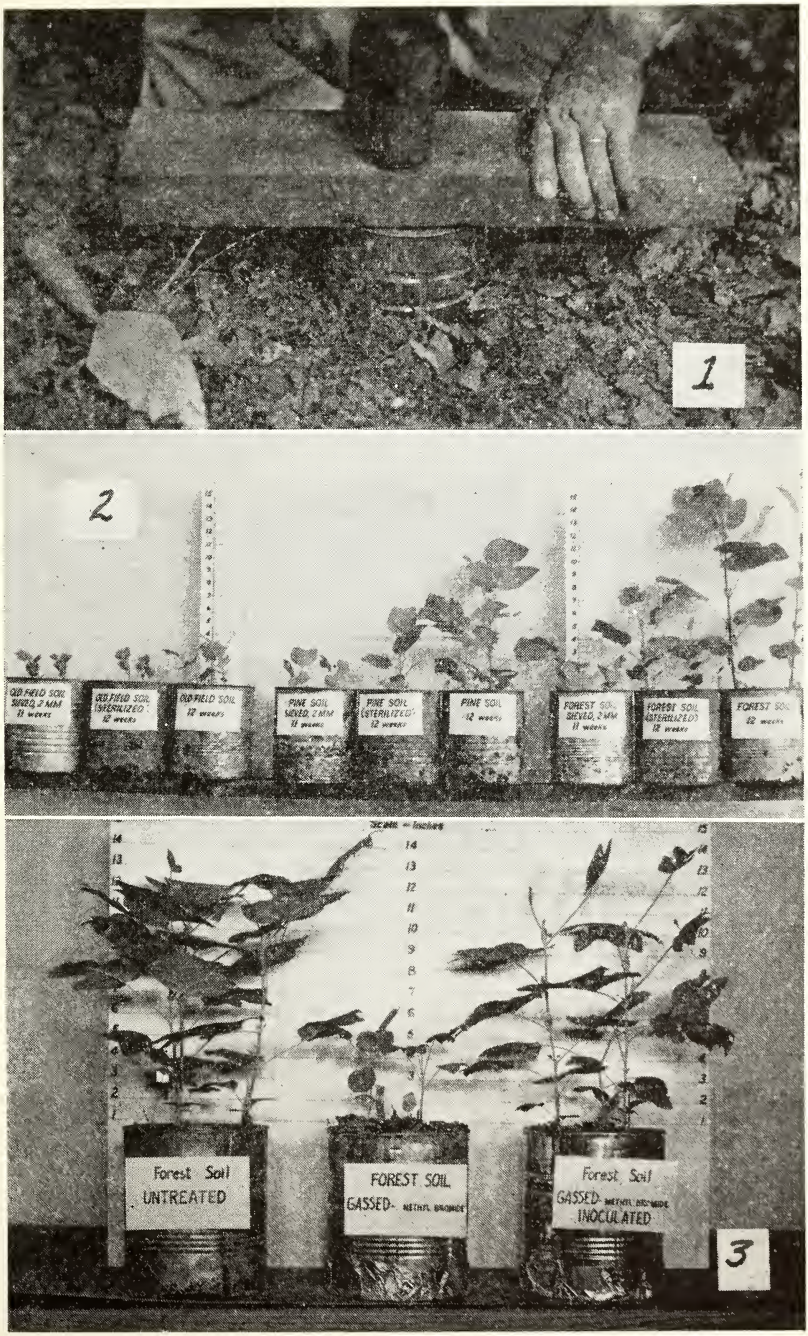
Figure 1. After the litter is cut the can is driven flush to the soil surface.

Figure 2. Growth differentiation of yellow-poplar seedlings by sites and treatments has been striking (scale in inches).

Figure 3. Seedlings grown in sterilized pots were much smaller than seedlings gown in untreated pots. Inoculation shows that microorganisms and not toxicants or change in soil structure are related to differences in growth (scale in inches).



Figures 1, 2 and 3

sterilized by three different methods to find a technique that would kill micro-organisms but would not change soil structure. The three methods were: heating at about 180° C for 1 hour, autoclaving at 104° C under 4 pounds pressure for 1 hour on each of 3 successive days, and gassing with methyl bromide in a closed container. Half of the autoclaved and gassed forest-soil cores were inoculated with untreated forest soil. Inoculation was done by punching three holes in the soil core with a metal tube ⅜ inch in diameter and filling the holes with plugs of untreated forest soil. Several newly germinated yellow-poplar seeds were planted in each pot. This species was selected for study because it is very sensitive to differences in soil. When the plants were well established, the seedlings were thinned to three per pot.

The first trial was made outdoors in full sunlight and the second in a laboratory under artificial light on a 14-hour day. After 12 weeks the seedlings were removed from the pots by soaking and washing in running water. Top and root length were measured and green tops and roots were weighed.

Results and Discussion

Results were striking and differentiation of growth by treatment was excellent (fig. 2): many differences among sites and treatments were statistically significant at the 1 percent level. Although the actual size of the seedlings means little, comparing heights among sites and treatments is a simple way to show the relative effect of various site factors on tree growth. For example, in the first trial seedlings grown in untreated forest soil were 4 times taller and 12 times heavier than seedlings grown in untreated old-field soil (table 1). Results of the second trial were practically the same where treatments were comparable.

TABLE 1

Size of seedlings grown 12 weeks in full sunlight by sites and soil treatment

Site and Treatment	Top Length[1]	Total Green Weight[1]
	inches	grams
FOREST SITE		
Untreated	8.8	10.9
Sterilized[2]	3.9	2.8
Sieved[3]	1.9	1.0
PINE SITE		
Untreated	4.7	4.8
Sterilized	2.6	1.3
Sieved	2.0	1.1
OLD FIELD SITE		
Untreated	2.0	0.9
Sterilized	1.4	0.6
Sieved	1.6	0.8

1. Mean value of 6 replications of 2 seedlings each.
2. At 180° C for 1 hour.
3. Seedlings grown in sieved soil were 11 weeks old.

Seedlings grown in inoculated, sterilized forest soils were as large as seedlings grown in untreated forest soils (fig. 3). Therefore, results were not due to toxicants produced during sterilization or to the destruction of soil structure by sterilization. Seedlings growing in sterilized pots were chlorotic while all others had good color, suggesting that the destruction of soil organisms was probably detrimental to seedling nutrition.

These preliminary tests demonstrate that large, undisturbed soil cores can be used to study various factors affecting seedling growth in the laboratory. Thus the uncertainties of climate can be greatly reduced. The method could be useful to soil scientists, foresters, horticulturists, plant physiologists, and plant pathologists. Variables other than those tested could be studied. Comparisons could be made among and within soil types, cover types, or treatment types. Response to fertilizer or chemical application could be observed in the laboratory. So far, only the top 7-inch layer of the soil profile has been studied, but there is no reason why lower parts of the profile cannot be sampled by first removing the upper horizons.