SOIL COMPACTION SLOWS EARLY GROWTH OF PLANTED COTTONWOOD

W. M. Broadfoot and F. T. Bonner[1]
Southern Forest Experiment Station
Forest Service, USDA

A recent study at the Southern Hardwoods Laboratory showed that when sandy loam soil is compacted to a bulk density of 1.60 the root and shoot growth of planted cottonwood cuttings is considerably retarded.

Farm equipment or animals compact and destroy a soil's original structure by decreasing the percentage of large pores, with consequent decreases in aeration, moisture infiltration, and movement of moisture and nutrients. Roots extend slowly, and growth and yield of agronomic crops are generally reduced (3). The drier the compacted soils become, the greater is the effect of compaction on plant growth (4).

Methods

The soil studied was a very fine sandy loam, typical of soils highly suitable for cottonwood and also of those that readily become compacted with use. The bulk density of forest soil of this textural class is about 1.3.

Enough soil to make the study was screened through 1/4-inch hardware cloth, air dried to approximately 1/3-bar tension, and placed in 6-gallon galvanized garbage cans. For aeration and drainage, the can bottoms were perforated with 1/4-inch holes and covered with a 1-inch layer of washed pea-size gravel.

The soil was compacted by dropping a 50-pound block of wood from a height of 12 inches for a specified number of times. All cans had an equal volume of soil after compaction.

Ten cans of each of three density levels were prepared:

Loose. Bulk density 1.0-1.2, as in recently plowed fields that have been settled moderately by rain.

Medium. Bulk density about 1.4, as in fields where soil compaction is not severe.

Hard. Bulk density about 1.6, as in fields with severe compaction.

One 10-inch-long cottonwood cutting from a good-rooting clone (Rosedale 8) was planted in each can during February 1964. A hole onehalf inch in diameter and 6 inches deep was bored in the soil at the center of each can, and the cutting was inserted snugly. A small amount of water was then added around the cutting and over the soil surface.

The cans were placed in the open and watered (with demineralized water) an average of twice a week until May and every other day afterward until the end of the test. To combat insect attack, granulated phorate was sprinkled on the soil surface in each can during April.

The experiment was terminated in July, after the seedlings had been growing 3 months. A longer test had been planned, but the trees began to display considerable leaf wilting and necrosis. Zinc toxicity was the probable cause, as leaf lesions were found to contain large quantities of zinc, presumably from the galvanizing on the cans. Because symptoms occurred randomly among the cans, it appeared that they did not affect results from the compaction. The plants were therefore washed free of soil, weighed, and measured.

Results and Discussion

The cottonwood had grown and developed best at a bulk density of 1.4 (table 1). Hard compaction (bulk density of 1.6) was clearly detrimental. This degree of compaction is equivalent to a total porosity of about 38

1 The authors are stationed at the Southern Hardwoods Laboratory. This laboratory is maintained at Stoneville, Miss., in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.

TABLE 1.--Development of cottonwood cuttings 3 months after planting in fine sandy loam soil at three levels of compaction[1]

Plant response	Soil compaction (bulk density in gm./cc.)		
	1.60	1.10	1.40
Shoot height (cm.)...	37.0	49.6	51.8
Shoot dry weight (gm.).....	4.42	5.02	7.10
Root dry weight (gm.)	.67	1.57	1.80
Primary lateral roots (No.).....	10.9	11.1	15.3
Surviving plants (No.).....	8	8	9

[1]Any two means not underscored by the same line differ at the 0.05 level when analyzed by Duncan's new multiple-range test.

percent. Hidding and van den Berg (?)f (found that root growth of rye, oats, barley, and potatoes was mechanically prevented when total soil pore volume fell below 40 percent.

The moderately slow growth at the 1.1 density level is probably a result of inadequate contact between the cottonwood cutting and soil. Flocker et al. (1) reported that yield of tomatoes increased as soil bulk density increased to about 1.3, but that further increases in bulk density (to 1.6) reduced yield.

In conclusion, the poor growth of cottonwood observed in old-field plantations during recent years may be caused partly by soil compaction. This condition likely was intensified in dry years as soil strength increased. Compacted soil can be loosened by deep plowing with large plows. Such plowing, done a year in advance of planting to permit some soil settling, would probably benefit cottonwoods.

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