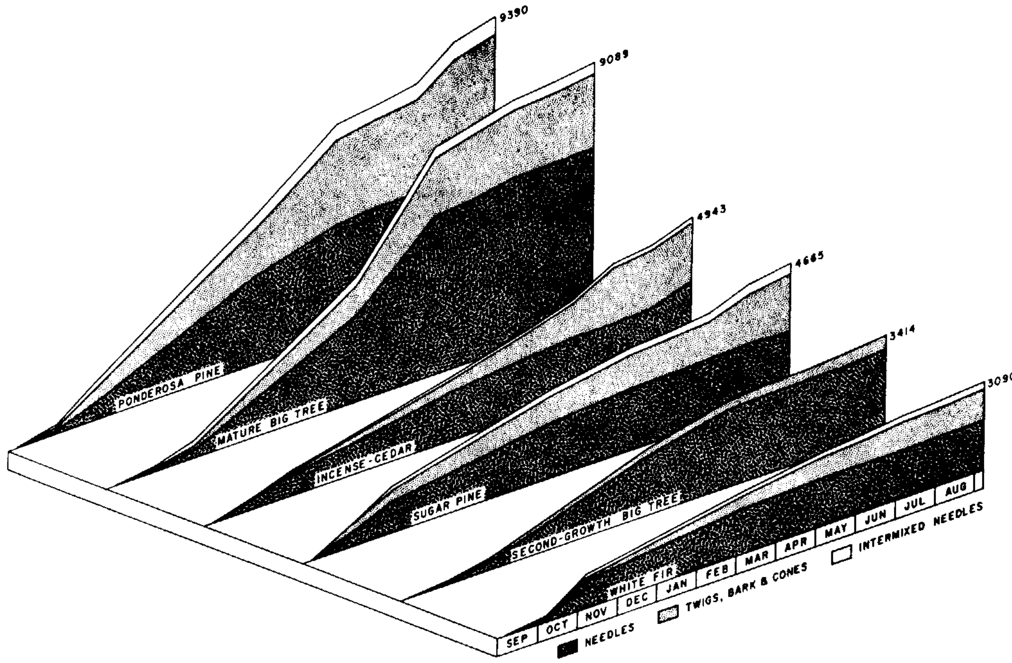
These studies show that the distribution and amount of litterfall under bigtree and pine canopies is such that bared areas will be well covered within a year's time. On the basis of amount of litter produced and ground covering potential, the pines are more desirable associates for bigtrees than are white fir or incense-cedar. Also, pine needles provide excellent fire-carrying fuels where prescribed burning is used to maintain low fire hazard conditions.



Accumulated weight of litter shed by various kinds of trees during a one-year period. The height of the vertical planes represents the weight of litter in pounds per acre, and total weights are shown. Values represent averages derived from six or, in a few instances, five collection trays. Accumulated values for collection falling on 5th of each month were used in plotting data.

LITTER PRODUCTION BY BIGTREES AND ASSOCIATED SPECIES

H. H. BISWELL · R. P. GIBBENS · HAYLE BUCHANAN

LITTER LAYERS PLAY an important role in forest ecology. Nutrient cycling, water infiltration and runoff, growth of understory plants, and fire hazard are all influenced by the kind and amount of organic matter annually shed by the forest canopy. The litter production of bigtrees, *Sequoia gigantea* (also known as Sierra redwood or giant sequoia) and their principal associated coniferous species, is being studied at Whitaker's Forest in Tulare County. Whitaker's Forest is a 320-acre tract owned by the University of California, located on the western slope of Redwood Mountain, and forming a part of the extensive Redwood Mountain Grove of bigtrees.

Whitaker's Forest was logged for sugar pine, ponderosa pine, and mature bigtrees in the 1870's. Most of the pines and about half of the mature bigtrees were felled. Following the logging operations a dense stand of incense-cedar, white fir, and second-growth bigtrees became established. Litter production by this stand of trees, now 80 to 90 years old, is being investigated as part of a broad study dealing with vista improvement, fire hazard reduction, improvement of conditions for wildlife, and development of management practices which can be used to maintain a primitive appearance—clean, open and parklike—in bigtree forests.

In the fall of 1964, six 3- × 3-ft trays with mesh bottoms were placed under the canopies of each of the following kinds of trees: mature bigtrees, second-growth bigtrees, incense-cedar, white fir, sugar pine, and ponderosa pine. Beginning on September 5, the material in the trays was collected at two-week intervals (except when covered with snow). Woody debris, such as bark, twigs, and cones, was separated from the needles before the samples were oven-dried and weighed. Each tray had 100% canopy cover of the desired species. The needles became intermixed at the ground level, however, since the height of the forest canopy permitted considerable drifting. However, the needles of other species intermixed in the trays were picked out and weighed separately. This procedure allowed a comparison of needlefall of the individual species and also the total amount of material deposited on the forest floor under 100% canopy cover of mixed conifers.

The accumulated litterfall for a one-year period is shown in the diagram. The "needle" category for bigtrees is an arbitrary one. Needles of bigtrees are scale-like; the portions shed from the trees are actually twigs, sometimes as long as two feet. Only those twigs or portions of twigs ¼ inch or less in diameter were classed as "needles" for bigtrees.

Ponderosa pine and mature bigtrees produced the most material (9,390 and 9,089 pounds per acre, respectively). The other trees produced roughly half as much. The proportion of needles to total litter was: ponderosa pine, 51%; mature bigtrees, 70%; incense-cedar, 56%; sugar pine, 55%; second-growth bigtrees, 86%; and white fir, 61%. Although needles are a major constituent of the annual litter fall, the data show that the woody debris contributes significant amounts of material, at least within the vertical projection of the tree crowns. This is especially true for white fir, which characteristically sheds many small branches, forming a very coarse, stemmy litter layer.

The period of maximum needlefall for all species was in the fall and winter as shown in the diagram. Incense-cedar began shedding needles in late August, but the other species did not shed needles in appreciable amounts until September or October. White fir had the most sharply defined period of needlefall: 53% of its needles were shed between October 5 and November 5. Snow prevented the collection of samples during December, January, and February. The interpolated lines in the diagram may mask peak periods of needlefall during these months. For all species, most of the needles had fallen by March 5, and few needles were shed during the spring and summer months. Woody debris was shed at a more uniform rate than needles, but much fell in the winter, probably due to the action of wind, snow and ice. These litter studies are being continued so that a measure of yearly fluctuation can be obtained.

Ground coverage

Knowledge of the rate at which litter will cover bared areas is essential to good planning for the use of cultural techniques. Four plots about 6 × 6 ft were laid out under each of the six kinds of trees. On two of the plots, all of the litter and duff was raked away, exposing the mineral soil; on the other plots only the litter layer was removed, leaving the duff layer intact. After a one-year period (Sept. 1 to Sept. 1), the plots were sampled with a 10-point frame to determine the amount of ground covered by new litter. The presence or absence of litter was recorded for 200 points on each plot, and the average values for the two plots of each treatment were calculated (see table).

The small, fine needles of incense-cedar and white fir provided less ground cover than the larger needles of the pines and bigtrees. More ground cover would be expected under ponderosa pine and mature bigtrees because of the greater volume of litter produced. However, sugar pine, with litter production roughly equal to that of incense-cedar and white fir, provided 70% ground coverage as compared to 51% coverage for incense-cedar, and 59% for white fir. Appearance of the litter cover of the various species is shown in photos. Depth of litter was a nebulous criterion because of the incomplete coverage, but the litter depths were greatest under ponderosa pine where the large, coarse needles formed a layer ½ to ¾ inch in depth. There was little difference in new litter cover between the plots cleared to mineral soil and those left with the duff layer. This indicates that no appreciable washing away of litter occurred on the totally bared plots.

After the point sampling was completed, the litter from three 3- × 3-ft plots on the areas cleared to mineral soil was collected, oven-dried, and weighed. For some species, the amount of material collected in this manner was less than that collected from the litter trays; for other species it was greater (see diagram and table). Site variation undoubtedly accounted for most of the differences. The

Appearance of the litter from various trees which fell on plots cleared to mineral soil during a one-year period. An area of one square foot is delineated by the metal frame.

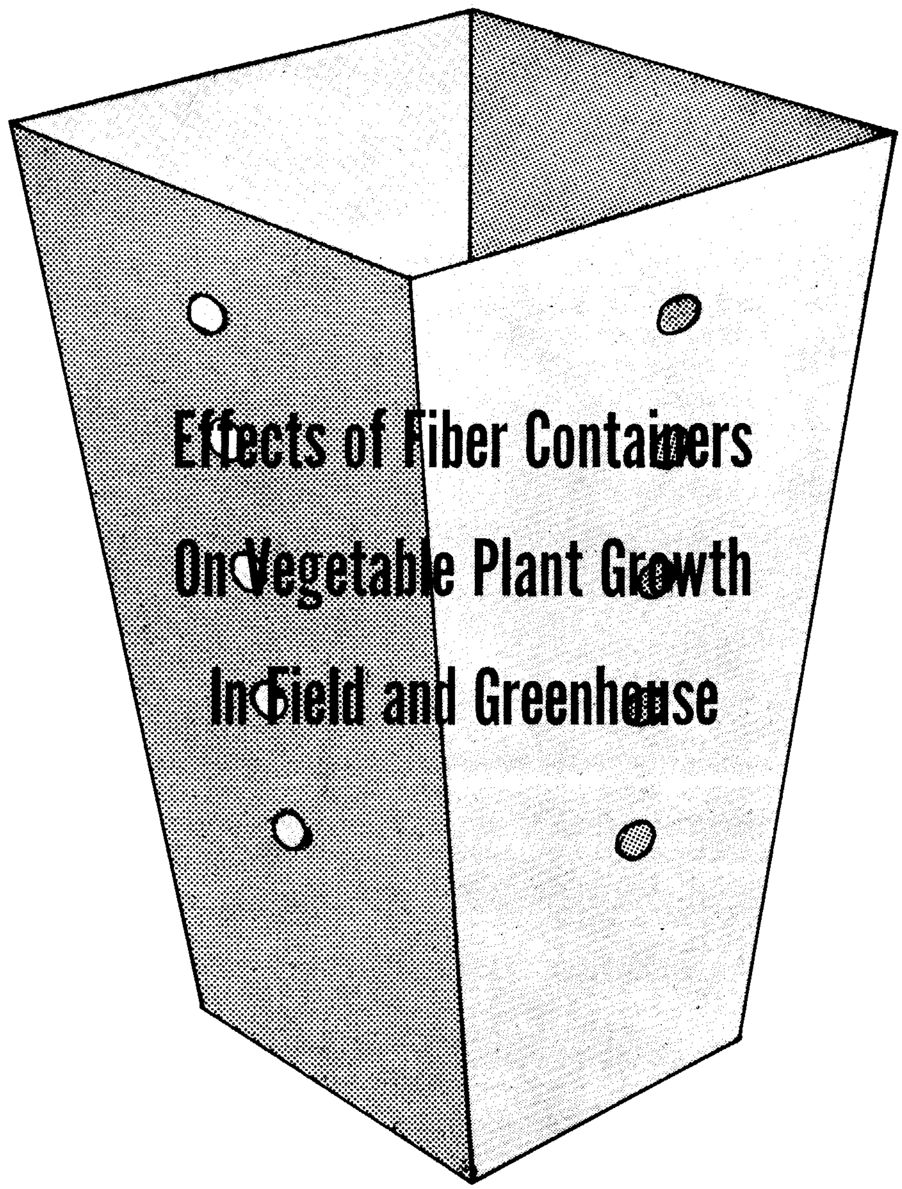
AVERAGE PER CENT OF GROUND COVERED AND WEIGHT OF LITTER FROM VARIOUS TREE CANOPIES DURING ONE YEAR (SEPT. 1 TO SEPT. 1)

Canopy	Treatment	Ground Cover Percentage*					Litter weight† (lbs per acre)
		Needles	Twigs, bark, & cones	Intermixed needles	New duff	Total new litter	
Ponderosa pine	Cleared to mineral soil	68.0	5.5	2.5	1.2	77.2	5,469
Ponderosa pine	Cleared to duff layer	65.3	4.0	6.2	0.0‡	75.5	
Mature Bigtree	Cleared ta mineral soil	49.0	20.8	2.0	0.2	72.0	6,250
Mature Bigtree	Cleared to duff layer	34.5	20.5	0.5	0.0‡	55.5	
Sugar pine	Cleared to mineral soil	57.0	8.8	2.0	2.0	69.8	3,719
Sugar pine	Cleared to duff layer	56.0	10.8	3.2	0.0‡	70.0	
Second-growth Bigtree	Cleared to mineral soil	45.8	14.5	0.2	0.5	61.0	4,095
Second-growth Bigtree	Cleared to duff layer	50.3	8.5	0.2	0.0‡	59.0	
White fir	Cleared to mineral soil	28.3	16.2	14.0	0.5	58.9	3,174
White fir	Cleared to duff layer	29.5	16.0	8.0	0.0‡	53.5	
Incense-cedar	Cleared to mineral soil	39.5	9.2	1.0	1.5	51.2	1,999
Incense-cedar	Cleared to duff layer	37.8	20.0	0.5	0.0‡	58.3	

* Percentages based on samples of 200 points taken on each of the two plots for each treatment.
† Weight of litter accumulated is for plots cleared to mineral soil.
‡ Newly formed duff nat distinguishable from ald, if present.

materials exposed on the ground probably sustained considerable weight loss through decomposition, however. More detailed studies of weight loss are underway so that the net accumulation rate of litter may be determined.

Harold Biswell is Professor of Forestry, and R. P. Gibbens is Senior Laboratory Technician, U. C. Berkeley; Hayle Buchanan was College Teacher participant under a National Science Foundation Grant. Dick Benner, Whitaker's Forest, assisted in collecting the litter samples.



Effects of Fiber Containers On Vegetable Plant Growth In Field and Greenhouse

G. H. CANNELL · A. H. HOLLAND · F. K. ALJIBURY

VARIOUS FIBER CONTAINERS are being successfully used for growing ornamental plants in nurseries, and some of these materials are now being used in vegetable crop production. Opportunities exist to increase their use in vegetable crop transplanting, particularly for special soil problems or under unique climatic conditions. However, several new problems arise in using fiber containers for vegetables that are not usually found with existing methods of bare-root transplanting. The problems begin with the initial stage of plant growth in the greenhouse and continue through maturity.

This investigation was concerned with various materials formed into containers of different types and sizes and their effects on plant growth, both in the greenhouse and in the field. Experimental paper materials used in these studies are referred to by the letters A, L, F_1, and F_2. The last two materials differed only in thickness: F_2 was approximately twice that of F_1. The sizes of containers were: $2\frac{1}{2}$ (top) × 1 inch (bottom) square and 6 inches high; and $2\frac{1}{2}$ × $1\frac{1}{2}$ inches square and 4 inches high; all open at the bottom. Five $\frac{3}{8}$-inch holes were cut in each side of the containers; the fifth hole placed 3 inches from the bottom. Peat and bagasse (sugar cane pulp) containers of various shapes and sizes were the other materials used in the test.

Peat containers

The peat containers shown in photo 1 are identified as follows: (1) $1\frac{3}{8}$ inches square and 2 inches high; (2) $2\frac{1}{2}$ inches square and $2\frac{3}{8}$ inches high; and (3) $2\frac{1}{2}$ inches diameter and $2\frac{1}{2}$ inches high.

In a second group, also peat moss, the numbers and sizes were: (4) $2\frac{1}{2}$ inches diameter and $3\frac{1}{4}$ inches high; (5) $1\frac{1}{2}$