pared with tensiometer-guided irrigation—except for the lignified wood which was not affected by irrigation treatment. The lower concentration of nitrogen in plants grown under set irrigation in soil, peat, and calcined clay was probably because the nitrogen was leached from the soil. The slow release of nitrogen from lignified wood kept adequate nitrogen available for the plant in spite of leaching. These results help explain the good growth of grass on lignified-wood-amended soil when irrigated under the set irrigation program.

ODR and root growth

The measured oxygen diffusion rate (ODR) values from containers receiving irrigation based upon tensiometer readings were all higher than 0.40 $\mu g\ cm^{-2} min^{-1}$. These values are not expected to be deficient for plant growth. It is possible that, if ODR measurements had been taken daily, ODR might have been in the deficient range for certain treatments for a period of time after irrigation.

In general, the ODR values under set irrigation were lowest in the unamended soil. Peat-amended soil was next lowest with the other two amendments providing an environment of fairly high ODR. Oxygen diffusion rate values measured in the noncompacted soil materials were higher than in the compacted unamended soil and peat-amended soil. The ODR values in the other amended soils were not greatly affected by compaction. The root growth was, in general, correlated with ODR measurements. The lower ODR limit for root growth was about 0.15 $\mu g\ cm^{-2} min^{-1}$.

The photographs illustrate the roots grown in the various soil mixes for various compaction and irrigation treatments. It can be noted that the lignified wood and calcined clay tended to eliminate the effects of overirrigation and compaction on root growth. Tensiometer-guided irrigation tended to reduce the ill effects of compaction on root growth in unamended soil.

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Comparison of Two Soil Amendments for Carnation Production

S. T. BESEMER · D. H. CLOSE

CARNATION GROWERS utilize any of several bulky organic materials for amending greenhouse soils to improve aeration, drainage, and moisture retention. Redwood sawdust has been the standard material used in San Diego County. The trial reported here compared plant growth and flower production of carnations grown with two soil amendments—10 and 20% by volume of Redwood sawdust, and 10 and 20% by volume of processed lignin particles, replicated three times. They were conducted at Hillside Floral Company, Encinitas, and the amendents were incorporated in a Carlsbad sandy loam in raised benches prior to planting. The greenhouse soil had not been previously amended.

Each series of replications was planted to a Sims carnation variety (red, pink, white) in mid-July, 1963. The plant spacing was 3.15 plants per sq ft of bench area. First blooms were cut in late October. Daily harvest records of blooms were recorded for each treatment for one year. Grades were not recorded. Periodic checks were made for differences in growth and bloom quality.

Based on the conditions of this experiment, a 20% addition of processed lignin particles to a previously unamended soil, produced about 3½ additional carnation flowers per sq ft of bench in 12 months of flower production as shown below:

FLOWER PRODUCTION, AVERAGE OF THREE REPLICATES FOR ONE YEAR

Treatment	Flowers per sq ft of bench	Flowers per plant
Lignin 20%	54.80*	17.14
Lignin 10%	51.50	16.45
Redwood 20%	51.23	16.38
Redwood 10%	51.02	16.13

*Significantly different (5% level).

If this difference could be obtained in commercial practice, a 20% addition of processed lignin particles would produce an economic gain despite its higher initial cost (see table).

From observation as well as data recorded, it appeared that the gain in production with addition of 20% lignin was due to a more rapid early growth of the plants and more rapid crop cycling. Flowering of the first crop was about two weeks early where the 20% lignin treatments were applied. It was also apparent that a 10% lignin addition was insufficient to produce a measurable production response. Redwood at 10% and 20%, and lignin at 10% were statistically the same.

Soil amending is but one of many cultural factors affecting flower production. Response may vary considerably depending on the type of soil to be amended. Economic extrapolations are particularly difficult in flower-producing enterprises because of the many differences in grower practices, such as plant spacing variations, percentage of greenhouse area in production, the area involved in replanting, the time of year that flowers are produced, average price received, and flower grades. Growers interested in comparing redwood sawdust and processed lignin particles for amending soils for carnation production should compare the two materials, each at 20% by volume of soil, on a trial basis. Accurate flower harvest records should be kept with occasional quality grade-outs. Additional data will also be needed to determine relative responses in the second year of production.

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COST OF PRODUCTION ESTIMATE PER SQ FT OF BENCH

	Redwood 10%	Redwood 20%	Lignin 10%	Lignin 20%
Per sq ft				
Basic costs[a]	$1.0000	$1.0000	$1.0000	$1.0000
Soil amendments[b]	.0037	.0074	.0222	.0444
Flower handling[c]	.5102	.5123	.5150	.5480
	$1.5139	$1.5197	$1.5372	$1.5924
Per flower				
Cost (cents)	2.9673¢	2.9664¢	2.9849¢	2.9058¢

[a] Based on a 1958 Carnation Cost Study, San Diego County, Agricultural Extension Service, University of California.

[b] Based on costs of $2.00 per cu yd for Redwood sawdust and $12.00 per cu yd for processed lignin particles.

[c] Flower handling is that portion of production costs, such as disbudding, banding, cutting, grading, and bunching, that is accrued per flower, and increases with the number produced.