Rx: Greenhouse Soils

Field Soils Must Be Changed when Growing in Bench, Flat or Pot

By O. WESLEY DAVIDSON

It is rare, indeed, that a field soil can be used in a bench, pot or flat with satisfactory results. The field soil, in practically all instances, must be composted or it must be mixed with peat, sawdust, sand, perlite, leaf mold, sod, manure or similar materials, for satisfactory results. Greenhouse operators know how to prepare good productive soils. But it seems that few really understand what properties of the soil they are changing. They realize that they want to improve the physical condition of the soil and its nutrient status.

Basically, the seeked-for improvements are necessitated by the fact that growers want to grow plants in containers, i. e., benches, flats and pots. If a good field soil were placed in a bench five to six inches deep, the moisture-holding capacity and the volume of air in it would be considerably changed as compared with the same soil in a well-drained field.

Editor's Note—This article is based on a talk on "Greenhouse Soils" presented by Dr. O. Wesley Davidson, of Rutgers University, New Brunswick, N. J., at the North Carolina short course held at Durham, N. C., this year.

Dr. O. R. Lunt, of the University of California at Los Angeles, has estimated that the average sandy greenhouse soil in the field holds only about 8 to 9 per cent of available water per cubic foot. The same soil placed in a 6-inch bench will have a water-holding capacity of 15 to 18 per cent. This will reduce the air space from 31 to 10 per cent, a serious condition. It is this "change" that necessitates most of the work done to soils to adapt them for greenhouse use. If the afore-mentioned soil were to be used in a 3-inch flat, then the situation would become even

less favorable. By merely bringing such soils into the greenhouse, the grower is changing their moisture-holding properties and their capacity to provide adequate aeration for the crops.

The underlying principle concerned with this change probably was first described by the Russian soil scientist Lebedev at the first international soil science congress at Washington, D. C., in 1926. He showed that if a soil is placed in a container and given a thorough watering, then the distribution of moisture, when the free water has drained off, will decrease progressively from the bottom of the container to a height of nine to 12 inches, according to the soil used. In other words, a soil 12 inches deep in the field will have approximately the same moisture and air contents in the portion 11 to 12 inches below the surface a day after a good rain as will the lower inch of the same soil in a flat the day after a watering. Unless peat, coarse sand or some similar materials are added to the soil in the flat, it will be too wet and too poorly aerated. In the field, however, the same soil probably would not have objectionable properties. Hence, in a greenhouse soil, the grower must develop especially good drainage and aeration.

Because the roots of the plants are confined the nutrient supply of the soil must also be increased to compensate for the reduced "foraging" capacity imposed on the roots of greenhouse crops.

In efforts to prepare greenhouse soils with properties suitable for the best purposes many practices that may be called fads and fancies have been adopted.

Pile Composting

Pile composting may be classified as one of these fads, but there is real doubt in my mind as to whether it should be called a fad, because it is a good, sound, effective practice, and it has served floriculture well. However, there are at least three serious criticisms that can be raised against the practice today. First, it is too expensive insofar as the ingredients are concerned. Second, it is too time-consuming, considering the time that must elapse for the composting process to be completed and the labor required to accomplish composting. Third, because of the large amount of organic matter and the unstable nature of much of the organic matter present, it does not adapt to present-day sterilizing techniques, particularly steam sterilization.

Where large amounts of soil are required and space, tractors, manure, sod or cover crop materials are available, field composting is still a good, effective method for the preparation of greenhouse soil, and it need not be comparatively expensive. Nevertheless, depending upon how the composting is done with respect to time, thoroughness and materials used, this method, too, may not adapt itself well to present-day sterilizing practices.

The first reference that I have on subirrigation is in Ward's book, "The American Carnation," published in 1903. Some Long Island (New York) carnation growers, at that time, were enthusiastic about the crop production and laborsaving features of subirrigation. This, however, was an injection-type subirrigation and was not so critical nor so costly as is the constant level subirrigation. The method had serious limitations insofar as the spread of soil-borne diseases was concerned and it did not offer the advantages that most growers felt were needed for the investment and critical attention that it required. Probably because of that, the method was practically forgotten for a period of about 40 years.

Hydroponics

Until the late 1920's hydroponics, or soilless culture, be it water culture, sand culture or gravel culture (the last-named method perhaps did not come into being until about 1935), had been a research tool and was not used for commercial production methods. During the 1930's some persons thought that the artificial methods would replace soil. Actually, the hydroponics methods taught much about soil nutrition and they also showed that soil has advantages over hydroponics in many cases. Most of the laborsaving features that seemed so apparent in hydroponics are now available in one form or another to soil culture. The artificial media in this case required exacting care, relatively high investment and, for some crops at least, inadequate protection against the spread of disease.

Revived and modified in the early 1940's, constant level subirrigation spread like wildfire during World War II and particularly for a few years thereafter. Lack of appreciation of the soil requirements for this technique, inadequately developed fertilizer practices for it and the limitations on its use where water of adequate quality was not available caused this method to lapse into relative disfavor. However, subirrigation does have advantages, and it is still used with excellent results with some crops. Nevertheless, it became a fad and, subsequently, a passing fancy for many growers.

Sand-Peat Mixes

The present vogue in this country seems to be the use of sand and peat mixes. Some growers have adopted such a mix because they think it is important to have a medium that can be prepared the same every time. Some have adopted it because they hope it will give them better results than they had with soil mixes that they had been using previously. Some growers think that it is less expensive than the media they had used before, and others, perhaps, use it because they are always looking for something new, and, at the same time, are hoping it will be better than what they have used in the past.

These sand-peat mixes have real and serious limitations. Before a grower adopts them he should ask himself "Can I get a reasonably suitable soil in my particular area?"; "Just what should I expect in the way of improved crop production from such a mix?"; "Is soil too expensive in my area?", and, lastly and most important of all, if the grower produces potted plants, he should ask himself "Will the sand-peat mix give my customers the best satisfaction with the plants that they buy from me?"

Clay-Peat Mixes

In Europe, mixtures of clay and peat are extremely popular. Here is what appears to be a diametrically opposite approach to obtain a rooting medium for greenhouse crops. Nevertheless, when the merits of the clay-peat mix are examined, they are found to be very real. Clay-peat mixes, when properly prepared, have excellent aeration. They hold relatively large quantities of water and extremely large quantities of nutrients; also, a potted plant grown in such a medium will need fertilizer infrequently, if at all, during the time that the plant is used by the ultimate consumer.

I have purposely not mentioned the John Innes composts under this list of fads and fancies because I do not consider them such. The John Innes mixes, particularly the potting composts, comprising seven parts loam, three parts peat and two parts sand, have been slightly modified by most growers and used satisfactorily for many years. The approach that they represent, I believe, is a basic one.

Perhaps it would be appropriate now to reconsider why a greenhouse soil should require any different treatment than a soil to be used for a field crop. Is it just because cultivating is done extensively on a small area in the greenhouse and therefore maximum results are desired for the efforts invested? Is it that in preparing soils for greenhouse use a technique has been developed that the average farmer would want to use if he could afford to do so?

The answer to these questions is certainly a most emphatic no. The outdoor farmer does not need to prepare his soil as greenhouse growers do for their crops. If the farmer has a good soil, then the chances are that it is providing his crops with the properties that greenhouse growers are trying to build into their soils. Greenhouse growers are forced to treat their soils because they are growing crops in containers of some sort, such as benches, pots, flats and so on.

The organic matter that is added to greenhouse soils serves two purposes: It supports the growth of microorganisms which give rise to the production of cementing materials that develop a crumb in the soil, and the organic material in the coarse sand pushes apart the soil particles to give larger pore spaces (larger amounts of air). What is really wanted is a bench, pot

or flat that is half full of soil and half full of air. That is just about a minimum. Many good potting soils comprise more than 50 per cent of air by volume.

When the necessary amount of air space exists there are large pores in the soil. The large pores are the ones that count, as far as carrying off the excess water is concerned and for providing good aeration for the roots.

Secondly, when the roots of a plant are confined, thereby restricting the "foraging" capacity of those roots, the nutrient concentration must be increased proportionately to compensate for this decreased "foraging" capacity. This is not corrected merely by applying more fertilizer; it necessitates developing a suitable nutrient retentive capacity in the soil. It requires an orderly method of storing nutrients which soil men refer to as exchange capacity.

It may also be referred to as storage capacity, in the sense that things are put away in an orderly fashion on the shelves of a storeroom. They are available when needed. They are not an obstruction unless the shelf space is overloaded. In such instances, the fertilizer is apt to burn roots.

For several years soil men have been interested in the properties of various soils that might be used for greenhouse purposes. Some 15 or 18 years ago, a study was run in which supplies of the most abundant soil series in New Jersey were obtained. They were taken to New Brunswick, N. J., and mixed with appropriate amounts of fertilizer, lime and peat moss for growing geranium plants. The results of this work showed that all of those soils could be adapted satisfactorily for use in the greenhouse. Some were better than others, but usually the differences between them could be compensated by differences in the amounts of peat, lime and fertilizer which were needed to be added to them.

From this work, the researchers went on to see how soils could be prepared for specific purposes and how certain properties could be developed to high degrees, such as aeration, exchange capacity, long-lasting property and lightness. More recently, work has been done with mixtures of soil, peat and perlite and several other materials. Perlite, a heat-expanded aluminum silicate, depending upon how it is prepared by the company processing it, can be an extremely durable material that imparts excellent aeration properties to a greenhouse soil while at the same time reducing the volume weight by a striking degree. The properties of peat moss, on the other hand, are somewhat misleading with respect to nutrient-holding capacity. Although the exchange capacity of peat moss per 100 grams (which is the usual basis on which soil men compare the exchange capacity of various materials) is 20 to 30 times that of a moderately good field soil, because of the lightness of peat moss, a cubic foot of this material has only about one and three-fourths to two times the exchange capacity of a similar volume of a moderately good field soil.

Greensand, a material found in extensive deposits in several areas of New Jersey and adjoining states, has has an exchange capacity, on a cubic foot basis, of about twice that of peat moss. Greenhouse soils prepared with green sand, peat and soil, as a consequence, have high nutrient-holding capacity.

It has been shown that when peat is added to a greenhouse soil it does not increase the available moisture too much. Dr. O. R. Lunt, of the University of California at Los Angeles, has shown that the increase is sometimes less than 10 per cent, but he also showed that with the addition of peat it increased the air content or air space by 10 per cent, which is extremely significant.

Properties of Potting Soil

For a number of years, recommended as a good potting soil has been the following: Three parts loam, two parts peat moss limed with pulverized limestone and approximately one-half to one pound per cubic foot of peat moss plus one part sand. Other states in the northeast have recommended approximately comparable mixes with satisfactory results. Soils comprising approximately one-third peat moss have about the same weight per cubic foot as do the 50 per cent sand and 50 per cent peat moss mixtures. The former weighs approximately 60 pounds air-dry as compared to 55, but the former will also hold over 10 per cent more of the basic nutrients.

If you were to change that to a three parts loam, two parts peat, one part perlite mixture, you would reduce the weight by approximately 20 per cent without changing the nutrient-holding capacity. The resultant mix would have much better physical properties and they will have been attained at a cost of about the same as the 1:1 sand-peat mix. Some growers can substitute a good clay loam soil for a loam and make a mix with perlite as follows: Three parts clay loam, two parts peat moss, one part perlite. This will have a basic nutrient-holding capacity of approximately twice that of the sand-peat mix and, in addition, it will weigh about 20 per cent less.

If you want to make a potting soil, perhaps, which is equal in desirable physical properties as well as nutrient-holding properties to the clay-peat soils used in Germany, you might use one part clay loam, two parts peat moss, one part perlite, one part greensand. Greensand is glauconite, a mineral found in extensive deposits in New Jersey and other eastern states. It has about the same weight as sand, but, unlike sand, it has high base exchange capacity per unit volume. This last mix would weigh slightly less than and would have an exchange capacity of twice that of the 1:1 sand-peat moss mix. Such soils prepared with perlite and green sand, moreover, have excellent physical properties and will retain them for months or years.

It is important that pot plant customers be given soils that have a good nutrient-holding capacity. A grower should not expect the customer, whether he is the florist who buys potted plants in two or three dozen lots and keeps them in his small greenhouse until he sells them or the ultimate consumer, to have to fertilize the plants frequently in order to maintain suitable growth and appearance.

There are a number of other considerations that must be dealt with when adopting a sand-peat bench soil, potting soil or flatting soil. In the first place, the California people recommending the U. C. soil mix system refer to fine-textured sand as that which corresponds to the wind-blown sand deposits of many areas. It is finer in texture than plasterers' sand. Such fine sand is what some of south Jersey growers might call good soils. Nevertheless, some florist greenhouse operators, adopting a system, have considered that sand is sand. In this respect, the U. C. mixes have the same criticisms that some have raised against the John Innes and other mixes: All soils are not the same. Few are so difficult to work with, for example, as are coastal adobe soils of California. Probably the unfavorable properties and untractable nature of these adobe soils had much to do with the development of the U. C. soil mixes. Fortunately, there are no adobe soils in the east. Fortunate, also, is the fact that it would be rare indeed for an eastern florist to attempt to use a soil so difficult and so unsuited to greenhouse purposes as are the coastal adobe soils of many parts of California.

Actually, most eastern soils that are not too rocky or gravelly, as well as those that are not found in areas that are wet and poorly drained, can be made suitable for greenhouse use, particularly when they are mixed with peat, sand, perlite or other materials, such as greensand. Most of the soils available from real-estate developments are suitable for greenhouse use. Obviously all of them cannot be handled in exactly the same way. Men in the various floriculture departments of universities have long recommended that soil sources be tested before the soil mix is made up and used.

Good for California

In addition to trying to present a clearer picture of what is trying to be reached by soil men when making a greenhouse potting soil (particularly designating the properties wanted and needed in such soils), I want it also to

be understood that the sand-peat mixes of the U. C. system are extremely good and suitable for California, although many of the large operators there do not use the proportions and ingredients called for by the U. C. mixes.

In the east, growers will find (in their back yards, so to speak) the basic materials needed for creating good greenhouse and potting soils.

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College Day

What you will see and hear

October 14, 1959

A number of fine new seedlings in light pink and salmon -- These are in 4-row plots so most all of them will have several flowers in various stages of openings. Also two very fine Orchid Beauty seedlings to give us a disease-free variety in this color.

The phenomenal growth of young carnations which receive additional carbon dioxide in the air.

Our latest progress report on the effects of greenhouse coverings other than glass on plant growth. This work is being expanded.

Up-to-date temperature recommendations for maintaining the best quality and cut flower life of carnations.

And a lot more!!! Starting time 10 a.m. Lunch at the Student Union Cafeteria. Afternoon Session and skull practice.

your editor,
W. D. Holley

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