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Control Of Soil Moisture

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The relationship between water content and soil type determines the aeration characteristics of a soil. Once a crop is growing, control of the amount of water in the soil is the only means of maintaining or regulating aeration. If we are to intelligently regulate moisture content, it is essential to understand the principles governing moisture level and the difficulties which may be encountered.

We have dealt with the behavior of water in greenhouse soils in N.Y.S.F.G. Bulletin 192. It has been stated the rate of oxygen supply to the plant root may be regulated by varying the amount of water present in the soil, or by using soils with different physical characteristics. Figure 1 shows the condition existing in a moist soil. Increasing the amount of water in the soil, increases the thickness of the water film surrounding the root and decreases the rapidity of oxygen delivery to the root surface. Smaller soil particles effectively increases the diffusion-path-length of oxygen by increasing the distance oxygen must travel. With this general concept of the path of oxygen in the soil and its relationships, we would like to report on the control of moisture in greenhouse soils.

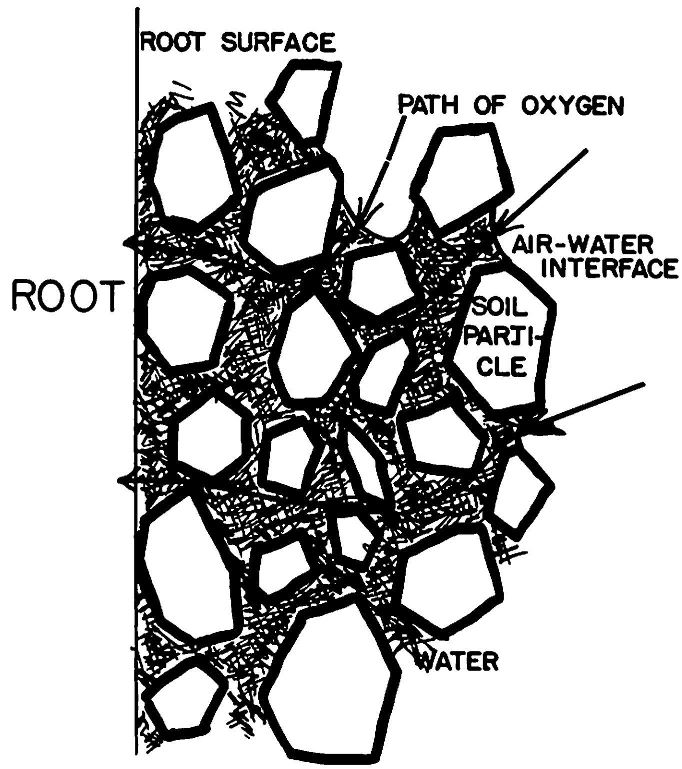

Figure 1. Diagram of a root surface and the surrounding soil particles and water film.

Approaches to moisture control in greenhouse benches.

It is not possible to select the optimum water content for a bench soil and to maintain this water content at all times throughout a soil. Various compromises are possible. One approach provides a constant water table. If the soil is not too deep, the water content will not change with time in spite of evaporation losses. In this case, the lower part of the soil is likely to be much too wet for satisfactory root growth. The soil will be less wet as the distance above the water table increases. If the soil is deep enough so that the surface approaches a desirable water content for plant growth, one may find that the surface no longer maintains a constant water content, but dries out when evaporation is high, and is slow to recover the desired moisture content. This means that the zone for best root growth may be fairly thin, and moves down or up as evaporation losses increase or decrease. In any event, the selection of proper depth of soil in accordance with the soil type becomes critical. Otherwise, a shallow soil may be too wet, a deep soil too dry in the upper layers.

A second approach involves surface applications of water at controlled intervals in shallow benches. These must be timed to prevent excessive drying between applications in times of high evaporation. With this method, the soil may be too wet initially, but passes through the desired moisture content as water is evaporated. The problem is to "bracket" the optimum condition so that the plant does not suffer from too much or too little water. Tensiometers and other devices may be used to track the progress of drying and to establish the time for rewatering. In general, this approach is most common and simplest in practice.

A third approach has something in common with both of the previous methods. As pointed out previously, the bottom of a drained bench simulates the presence of a water table so long as water losses are primarily by drainage, rather than by evaporation. An individual may then choose a suitable soil depth, to fix the position of this virtual water table. A properly selected soil of the proper

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depth will drain rapidly after surface irrigation, bringing the surface soil to a water content near that best for root growth. Evaporation causes the zone of optimum water content to descend through the soil, but the cycle can be repeated by re-watering. If the root system of the plants extend through the soil layer, water removal may occur throughout the bench, and the water table may disappear quite rapidly. This method does not require a water-tight system like that of the constant water table system, nor does it need the careful monitoring of water content and irregular watering schedule of the second approach.

Review of theory

In a previous publication, it was pointed out that a decrease in water content is associated with an increase in soil moisture tension (SMT). In a bed of soil that has been wetted and allowed to drain (without evaporation) from the bottom, SMT will be zero at the bottom of the bed when drainage ceases, and the soil is likely to be saturated there. At the surface of the bed, SMT will be equal to the depth of the soil layer, and in general the water content will be below saturation. The coarser the soil pores, and the deeper the bench, the lower the water content at the surface is likely to be. "Bench capacity" was defined as the moisture content of the surface two inches of soil in a bench after this drainage process is complete. It represents the upper limit of water content to be expected in the surface soil except for brief period of actual watering and subsequent drainage. The deeper the soil, the lower bench capacity will be. If the soil is quite deep, however, the effect of added depth on bench capacity becomes quite small.

This article will describe some demonstrations of these approaches to water regulation.

Constant water table

Constant water tables were arranged at the base of beds of soil, 3, 7, 12 and 18 inches deep. One of these plots is shown in Figure 2. Soil moisture tension (SMT) was measured near the surface of each soil with the results given in Table 1 and Figure 3. It can be seen that in all soils, a constant water content was maintained when the soil was 3 inches deep, and that the measured SMT was the proper value, namely the height of the tensiometer above the water table. The peat-perlite mixture gave the intended constancy when 7 inches deep, but with greater depths, the constant water table system failed to keep the surface soil wetted to the proper degree, as upward flow could not keep pace with evaporation losses. The constant water table did not keep the 1-1-1 or soil mixtures wetted to the proper degree, except at the 3-inch depth. SMT increased above the proper value, and the soil fell to lower water contents than would be expected with little or no evaporation. It was suspected that the measuring instruments were not reliable at the high SMT's. In theory, the tensiometers are considered to be at their upper limit at 1000cm of water. In practice, however, porous cup tensiometers are not considered valid above 800cm.

In Table 1, it should be noted that the per cent air present in the 3 inch soil plus sand plot was 19. More recent data with a second crop in this same plot has indi-

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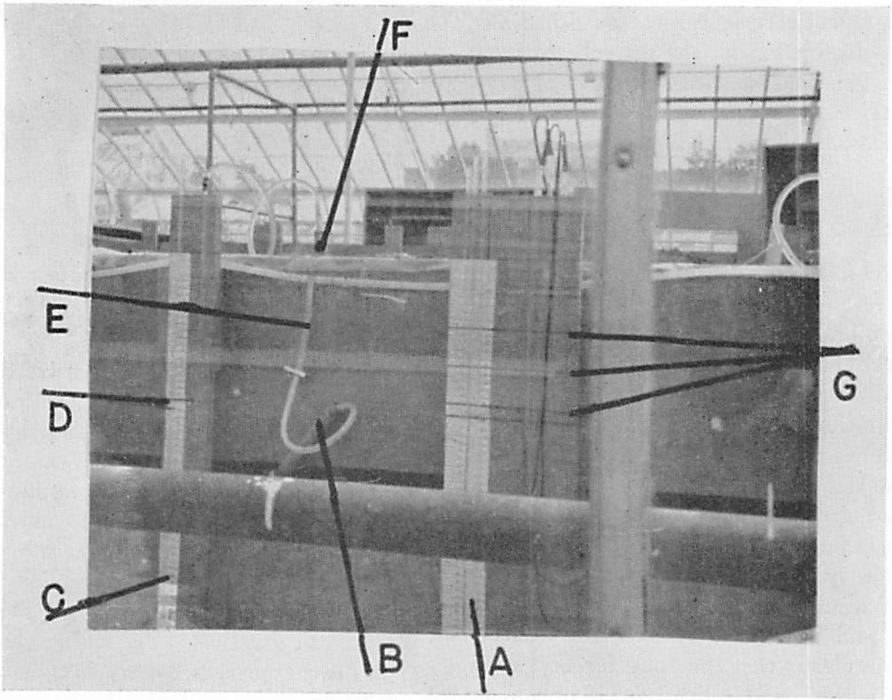

Figure 2. One, 7-inch soil depth, constant water level plot. "A"—Manometer boards with water-filled glass U-tubes for indicating soil moisture tension at various depths within the plot. "B"—Overflow pipe for adjusting water table. "C"—Manometer board for tensiometer located in upper layers of soil. "D"—Line on manometer board indicates location of water table. "E"—Water supply line to plot. "F"—Tensiometer cup. "G"—Lines on manometer board indicate placement of tensiometers at various depths within the plot.

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Table 1. The effect of soil depth on air, moisture content and soil moisture tension of three soil mixtures irrigated by a constant water table.

Depth	Mixture	Air Per cent	Water volume	Water Per cent dry weight	Average soil moisture tension[a]
3" (7.5 cm)	Peat-perlite	43	40	321	8.4
	1-1-1	24	40	44	8.5
	Soil	19	38	35	8.7
7" (17.5 cm)	Peat-perlite	48	34	288	18.1
	1-1-1	41	24	31	69.6
	Soil	34	24	25	77.7
12" (30.0 cm)	Peat-perlite	55	24	195	36.0
	1-1-1	47	12	16	485.4
	Soil	40	16	14	739.1
18" (45.0 cm)	Peat-perlite	60	19	151	118.1
	1-1-1	50	12	15	673.2
	Soil	36	17	16	768.0

[a] centimeters of water

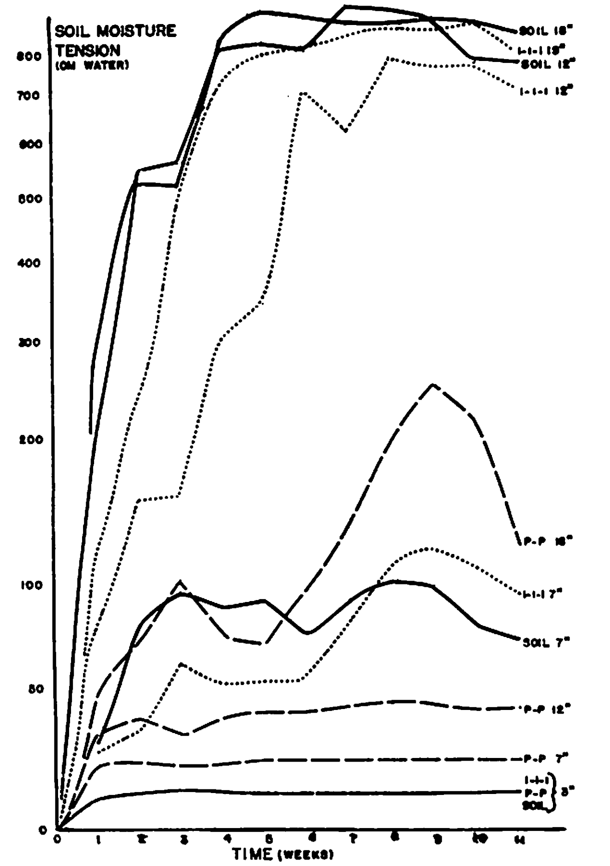

Figure 3. The course of soil moisture tension in constant water level plots. Data obtained from plots similar to the one shown in Figure 2. To correct data for actual soil depth, subtract 2.5 centimeters. Data from tensiometers located in upper 3-inches of soil.

cated a marked decrease in free pore space to less than 10 per cent. This is an indication of rapid soil break-down. However, the high free pore space present has shown us that this soil is the exception and not the rule. Most field soils under these conditions would be expected to have a free pore space, at a SMT of 8.7 cm of water, less than 5 per cent.

The results show that with these soil mixtures, controlled water tables provide effective moisture control only if the soil is shallow and very wet.

Controlled surface applications

Another set of plots, all 7 inches deep were watered when tensiometers indicated that a preselected value of SMT had been reached. One was watered when SMT reached 30cm water, another at 300cm water and the remaining one at 600cm water. The changes of SMT with time, and the frequency of irrigation required to meet the selected schedules are shown in Figure 4. The plots watered at 30cm were irrigated 14 times, those at 300 three times and the group watered at 600 only twice. It is also important to observe that during most of the growing period, conditions in the two infrequently watered plots were at least comparable. Only for a relatively brief period were the driest plots actually drier than the intermediate plots. Because the curves are rising steeply as drying proceeds, the delay required to reach 600cm SMT was not very long, and the rate of water extracted in this extra interval was probably about the same as in the other plots.

The important thing to be shown is that conditions can be held relatively "constant" under this type of moisture control only when irrigation is done while the soil is quite wet. Moisture content cannot be held constant at some intermediate level. The average SMT for the entire period is not a good representation of the actual conditions in the bench over the period indicated in Figure 4.

Another point to be made is that the frequency of irrigation is highly dependent upon the size of the plants and the environmental conditions to which the plants are subjected. In Figure 5, a comparison is made between two identical plots, one located at the exposed, cold, end of the greenhouse, the other at the warm end of the same house. The higher water requirement of the warm plot resulted in that plot being irrigated before its mate. Secondly, the initial water extraction rate for both plots was

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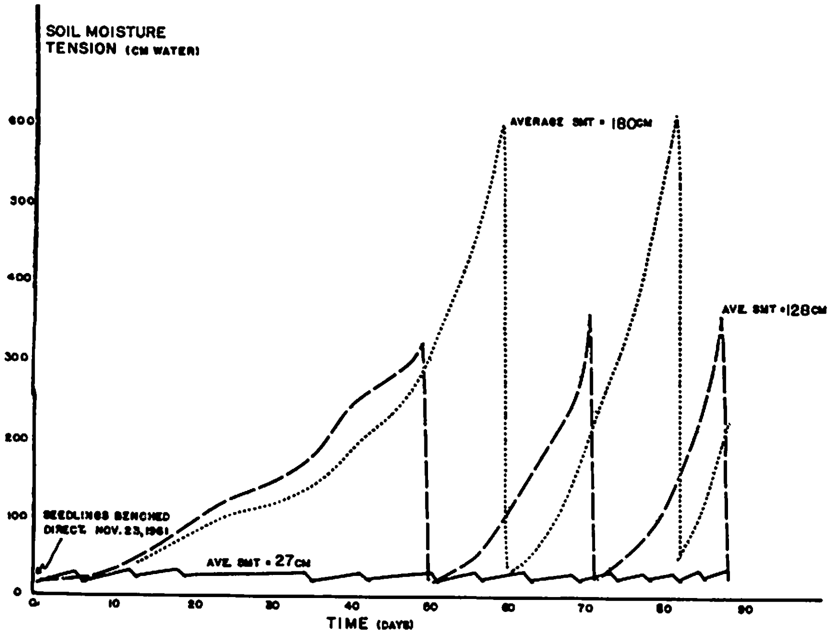

Figure 4. The course of soil moisture tension in overhead irrigated plots watered at pre-selected SMT's of 30, 300 and 600 centimeters of water.

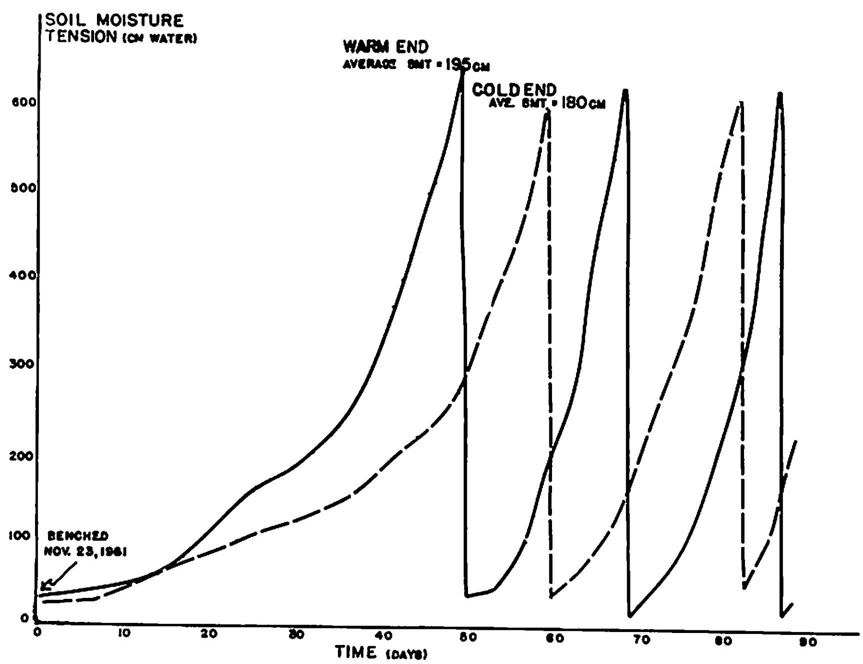

Figure 5. The course of soil moisture tension in two identically treated, overhead irrigated soil plots watered at 600 cm of water SMT, but located at different ends of the greenhouse.

slow due to the small size of the plants. By the time the plots had been irrigated, the plants had reached a stage of growth where drying out proceeded at a more rapid rate. This is reflected (Figure 5) by the short time required to reach 600cm water SMT after the first watering.

Variable soil depth

In the third approach to moisture control, benches containing soil 3, 5, 7, 9, 12, 18 and 24 inches deep were watered daily or when SMT reach or exceeded the depth of the soil. Tensiometers, installed near the surface of the soil, were read daily just prior to watering, and indicate the degree of drying of the surface attained in the interval since the previous day's irrigation. Figure 6 shows one of the benches. The tensiometer values are plotted in Figure 7. The numerals in parentheses give the soil depth in centimeters, and correspond to the theoretical value expected in the absence of evaporation. For the shallower depths, the observed values were, on the average, slightly drier than the theoretical value as a consequence of evaporation losses. In deeper plots, the observed values fell

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below the theoretical, indicating that within these deep soils, the drainage process was not completed in 24 hours. Even though the deep benches were still draining after 24 hours, it is also apparent that the surface soil of the deeper plots was significantly drier than the surface of the shallow plots. These results demonstrate the control of soil water that may be exerted by the simple expedient of adjusting soil depth. It is true that considerable depths of soil are required to avoid extremely wet conditions (with daily watering) when this method is used. Also, the amount of water required is likely to be excessive.

Summary

Results of the application of three approaches to the control of water in greenhouse benches have been described. Each has its advantages and disadvantages in practice. If all three are understood, the individual can appreciate the problems inherent in normal practice, and can consider what modifications might improve quality or reduce the labor of his watering practices. He can also appraise problems that might be associated with the soil he is accustomed to use in his benches and can consider how this might be modified to simplify his watering procedures.

It is important to remember that the water requirements of the crop as influenced by size of plant, light and temperature play an important role in determining moisture content of a soil under any procedure. Also, nothing is mentioned in this article about problems dealing with nutrient control, and the effect soil moisture content may have upon the quality of keeping life of cut flowers. Where soils are maintained wet by overhead irrigation, large amounts of fertilizer materials would likely be required.

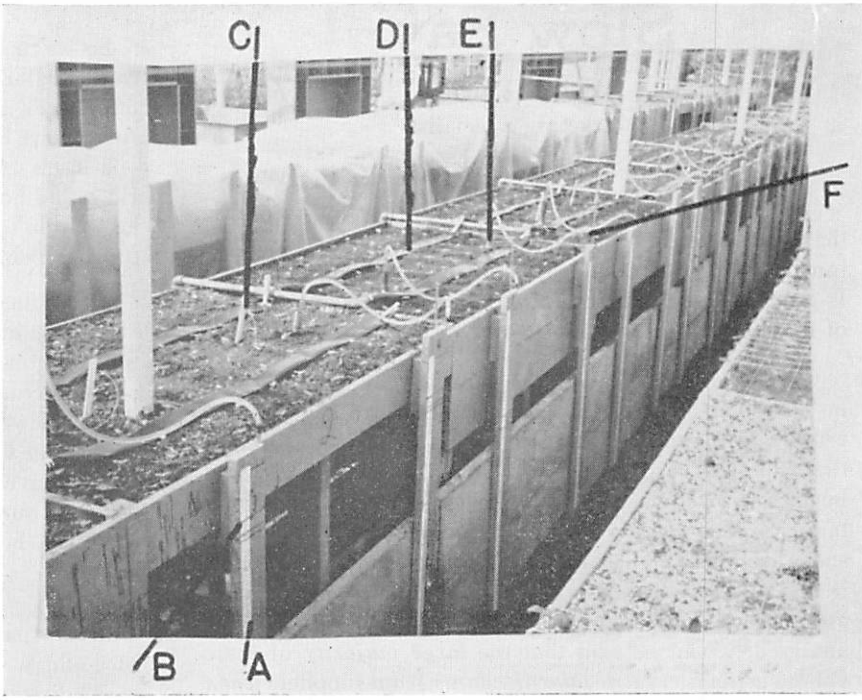

Figure 6. Two overhead irrigated, constant soil moisture control benches. "A" Manometer board with water-filled glass U-tube for recording soil moisture tension. "B"—The line marked on the board marks the bottom of the soil layer and represents the theoretical value of soil moisture tension when the plot has drained. "C"—The label marks the position of the soil-air sampling device. "D"—Black plastic Gro-hose for irrigating. "E"—Porous, clay, tensiometer cup for determining soil moisture tension. "F"—Water-filled plastic tube, connecting tensiometer and manometer tube.

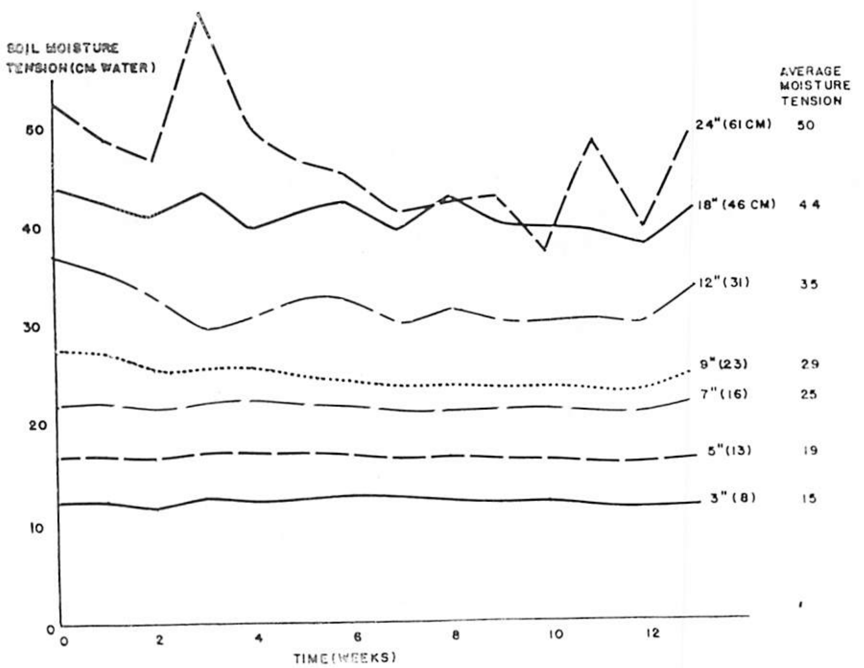

Figure 7. The course of soil moisture tension in overhead irrigated constant soil moisture plots during the period of crop growth. Soil mixture was a 1-1-1 soil, sand, leaf-mold mixture. Figures given in inches and equivalents in centimeters at 13 weeks are the depths of the plots and theoretical values of soil moisture tension when the plots have drained. Average soil moisture tensions at far right in centimeters for entire period of 13 weeks. Data obtained from plots shown in Figure 6.

Slow Pay*

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"Florists live from hand to mouth. They must because they operate on a shoestring and must wait for their customers to pay them before they can pay their suppliers." Is that statement true or false—or are there some shades of gray causing a hesitant answer?

Our humble opinion of the slow pay of florists would be a hesitant or a hedged answer. You are aware of 18 retailers volunteering for a business analysis project of their shops. This involves 22 shops, their records, and business procedures. Now, not all of these volunteer retailers are "average," but all are anxious to see how their shops compare with similar shops and want to do better if they can. While there are still only a couple of shop owners to visit before all the information will be analyzed, it can be said that the *large majority* of these volunteer retailers *will take discounts* from suppliers *when available,* at least three-quarters of the time. These are not "slow pay" florists but smart florists, yet these same retailers do not pay very promptly where cash discounts are not given. Ironical, isn't it? But, it is perfectly possible. Are these florists "slow pay" or a combination of prompt and slow? Yet, it doesn't seem that these retailers are much different from other retail florists in regard to slow pay.

GOOD BUSINESS

Most everyone would take advantage of a 2 per cent—or even 1 per cent discount in 10 days—net 30, on nonperishables or "supplies" (which most allied tradesmen offer). A 2 per cent discount in 10 days, net 30, amounts to 36 per cent *true* interest per year. A 1 per cent in 10 days is 18 per cent true interest. Can't most anybody borrow money at 6 per cent—thus saving 30 per cent and 12 per cent, respectively, of the 2/10 or 1/10 terms? The savings depend on, (1) value of supplies, (2) cash discount offered, *if offered* and (3) whether you must borrow to pay promptly.

Rate of return by taking the cash discounts is better than the *rate of return on your total business investment,* for probably 99 percent of florists businesses. In fact, if florists could transact enough business by borrowing at 6 per cent and being offered 36 or 18 per cent—that would be an easy way to make a living. Figure out your situation as to how much extra gross sales you need to "clear" the amount you save by taking discounts! How much you *could* save if *all* your suppliers (including wholesale florists) offered cash discounts? Or how you could get to know your banker better.

Let's say that we would *urge every type of florist* to take discounts whenever available even if it means borrowing to do it—at least check the terms to see if it's to your advantage.

FLORISTS' BUSINESS

So we're back to the "slow pay" of florists again. We contend florists are slow pay when there is no discount offered, or no penalty charge if overdue by a certain date. Any smart businessman would do the same—using someone else's money so to speak—in running his business. He would hold off on payment probably up to a point that he wouldn't endanger losing his supplier. This is what we think is behind the slow pay aspect of florists.

Many florists are involved in straightening out "slow pay." For instance, only a few wholesale commission florists offer cash discounts so those that do not offer discounts actually aid and *encourage* slow pay. Probably only a few wholesale growers offer discounts, at least from what we've learned from retailers. How many retail florists have a cash discount or a penalty charge if overdue? (Your phone bill has a *net* charge if paid by a certain date, beyond that you pay the gross charge.)

SO WHAT?

If slow pay is a "problem," each and every type of florist could work individually and through his association, to get discounts from those who don't offer them, and offer them to their customers. In this manner, the seller gets his money faster; can operate on less capital; reduces credit risks, collection and bad debt losses. It rewards businessmen.

A slow pay industry with no discounts, or penalties, allows some shoestring florists to be subsidized at the expense of financially sound florists with well-run businesses. Are you helping to maintain shoestring competitors?

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YOUR EDITOR,

Bob Langhans

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