PORE SPACE IN POTTING MEDIA

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Several years ago, growers of potted plants in northern California encountered unexplained difficulties in producing disease-free well-grown plants. Root rot problems were quite common. Watering and fertilization practices which had produced good plants in the past were not working. Two important changes were occurring in the industry at the same time. Growers were switching from clay to plastic pots while simultaneously changing potting media from a soil base to soilless mixes. Good top soil was beginning to become more difficult to find; consequently, structure and texture could vary greatly when the grower was forced to purchase the soil supply from several sources.

After exhausting several other possibilities as probable causes, problem media were examined for air and water-filled porosity. It soon became apparent that air-filled porosity had been overlooked frequently when formulating potting media. In most instances, growers preferred homemade mixes to the commercially prepared media because they were less expensive. Initially perhaps, but not in the long run when cultural difficulties were encountered.

Growers probably had more latitude in formulating potting mixes when plants were grown in clay pots. The porous clay allowed the media to dry faster than they would in plastic pots. When the latter came into general use, potting mixtures retained more water for a longer time. A complete change of management practices was in order. Growers who failed to modify their media and/or cultural practices soon had problems producing well-grown disease-free crops. Those who had well aerated potting mixes to begin with experienced little or no difficulties. Troubles were not necessarily confined to plants grown in cooler climates or under winter conditions.

Porosity of the potting mixture is only

one factor albeit an important one. An air pore space of 20% to 25% is considered by some eastern growers as being desirable while western growers feel 15% is sufficient. Along with these values, a water-filled pore space of 60% or more usually insures a potting mixture against being too droughty.

Probably the most important reasons for assuring adequate air-filled porosity levels in potting media are:

1. Oxygen is necessary for good root growth and activity.
2. Poor aeration in a medium invites root damage through oxygen starvation.
3. Roots so injured provide sites for disease entrance.
4. Disease organisms invading roots in a secondary way compound an existing problem.

The majority of potted plant growers in northern California mix their own potting media. Mass production of the crops is their foremost aim so in order to standardize growing practices profitably the following criteria must be considered:

1. Ingredients must be of consistent quality from one purchased batch to another.
2. The person doing the mixing must be reliable.
3. Price of ingredients can determine their choice but the cheapest material might not always be the best in the long run.

Ingredients and the proportions in which they are mixed vary tremendously from one grower to another for both soilless and soil containing media; consequently, it was decided to survey media from several growers to determine how important air pore space was in contributing to the difficulties being experienced by them.

Most large nurseries in California do not use a single all-purpose mix. Depending upon size, the number of potting media used by one firm could be as many as six or more. Growers in the Half Moon Bay and Lodi areas were very supportive of the survey program. Most samples reported hereafter were taken directly off the production lines. A few exceptions will be noted as they occur. No commercially available potting media were included in this survey. In order to maintain anonomity, all samples were code number and only the code corresponding to the samples taken from an individual nursery were supplied to the owner or operator. Whenever possible, potting mixes used for the same crop have been grouped together for ease of comparison. The various ingredis are shown in the top half of the following tables while pore space analyses are shown in a comparable sequence at the bottom.

In Table 1, sample 8001 contained a high percentage of air pore space. The soil used in this mix had very good stable structure. Had it been a fine textured soil with poor structure the air pore space probably would have been substantially lower. Mixture 8026 contained black scoria. This medium contained an excellent level of air pore space while the percentage in 8034, which contained red scoria, was quite low. Scoria was used in these instances as a substitute for styrofoam since both are relatively inert materials. The floatation characteristic of styrofoam made it objectionable due to

TABLE 1. COMPARISON OF CHRYSANTHEMUM POTTING MIXTURES USED BY SEVERAL NURSERIES.

	PERCENTAGE OF INGREDIENT							
CODE	FIR BARK	PEAT	SOIL	SAND	PERLITE	FOAM	SCORIA*	PUMICE
8001	26.0	30.0	21.0	-	23.0	-	-	-
8026	22.0	33.0	6.0	-	-	-	39.0^{B}	-
8004	50.0	25.0	-	25.0	-	-	-	-
8027	22.0	33.0	6.0	-	-	-	-	39.0
8034	20.0	30.0	30.0	-	-	-	20.0^{R}	-

CODE	TOTAL POROSITY % BY VOLUME	WATER CONTENT % BY VOLUME	AIR FILLED POROSITY % BY VOLUME
8001	78.8	45.5	33.3
8026	83.0	64.8	17.2^{B}
8004	74.8	59.3	15.5
8027	77.3	67.3	10.0
8034	70.5	61.9	8.6^{R}

*The letter R and B Refer to the red and black scoria used in the potting mix.

clogging of screened ditches and unsightly residue when washed off nursery property. Plants in mixture 8034 did not have the vigor of those in other mixtures reported in Table 1.

Particle size for both scoria types was supposed to have been 2mm to 6mm. When mixes containing red scoria exhibited consistently low air pore space levels, the shipment received from the supplier was sampled and tested for particle size. A prepurchase sample contained 8-9% fine material which passed through a 2mm screen. This was similar to the particle size found in black scoria. The delivered red scoria material was found to contain 35-37% fines. Apparently, in the handling process prior to delivery a high degree of fines accumulated from abrasion or other means. The color of scoria had nothing to do with the poor plant growth but rather the fine particle size in the red scoria which no doubt changed cultural requirements. This situation illustrates the need for uniformity of delivered ingredients.

Several potting media used for poinsettia production are shown in Table 2. As expected, there were great differences in air pore space percentages since the ingredients and their relative proportions were quite varied. Sources of supply for the ingredients were not consistent; consequently, the quality of peat, fir bark, etc. could have been extremely diverse. In spite of the differences, most of the crops produced in these media grew well. With the previous history of excess fines in the red scoria, mixes 8036, 8037 and 8032 were tested before the poinsettias were potted in them. The 8036 mixture was used on a limited scale for part of a crop but 8037 and 8032 both containing disasterously low air pore space were discarded. Fortunately, there was enough latitude in air pore space of the other media for most poinsettia mixes to provide a good environment for root growth. Attempts at predicting the effects of various ingredient combinations were virtually impossible due in large part to the inability of ascertaining ingredient quality from one nursery to another. By pretesting potting mixtures before use some cultural problems can be avoided.

The foliage plant potting mixes shown in Table 3 further illustrate the air pore space relationship between those mixes containing the red and black scoria mentioned previously. Ingredients in both mixes were the same with the exception of the type of scoria used.

Air pore space in mixture 8005 was extremely high. A good coarse grade of peat used was used in preparation of the medium. Since the percentage of peat used was fairly high, the quality of peat was probably the most important factor in producing the high air pore space value for the mix. Plants grew very well in this medium.

The grower who used mixture 8002 had difficulty in determining water application intervals. in addition, root rots from water molds were prevalent. Plants did not grow

TABLE 2. COMPARISON OF POINSETTIA POTTING MIXTURES USED BY SEVERAL NURSERIES.

	PERCENTAGE INGREDIENT							
CODE	FIR BARK	PEAT	SOIL	SAND	PERLITE	FOAM	SCORIA*	PUMICE
8012	35.0	30.0	-	17.5	17.5	-	-	-
8029	35.0	25.0	20.0	-	-	-	20.0^{B}	-
8013	21.0	30.0	-	21.0	-	28.0	-	-
8028	35.0	25.0	20.0	-	-	-	-	20.0
8036	25.0	30.0	20.0	-	-	-	25.0^{R}	-
8015	50.0	19.0	-	31.0	-	-	-	-
8037	30.0	35.0	-	-	-	-	20.0^{R}	-
8032	22.0	43.0	19.0	-	-	-	16.0^{R}	-

CODE	TOTAL POROSITY % BY VOLUME	WATER CONTENT % BY VOLUME	AIR FILLED POROSITY % BY VOLUME
8012	78.6	63.3	15.3
8029	77.4	64.1	13.3
8013	75.2	62.1	13.1
8028	76.3	65.0	11.3
8036	73.0	62.8	10.2
8015	73.0	63.1	9.9
8037	74.8	69.0	5.8
8032	75.3	74.5	0.7

*The letter R and B refer to the red and black scoria used in the potting mix.

TABLE 3. COMPARISON OF FOLIAGE PLANT POTTING MIXTURES USED BY SEVERAL NURSERIES

CODE	PERCENTAGE OF INGREDIENT						
	FIR BARK	PEAT	SOIL	SAND	PERLITE	SCORIA*	PUMICE
8005	14.0	55.0	10.5	-	21.0	-	-
8016	33.0	33.0	-	-	13.3	-	20.0
8024	21.0	42.0	-	-	-	37.0B	-
8025	21.0	42.0	-	-	-	-	37.0
8033	21.0	42.0	-	-	-	37.0R	
8002	25.0	62.0	-	12.5	-	-	-

CODE	TOTAL POROSITY % BY VOLUME	WATER CONTENT % BY VOLUME	AIR FILLED POROSITY % BY VOLUME
8005	85.3	52.7	32.6
8016	85.5	59.0	26.5
8024	86.3	64.5	21.8
8025	83.8	65.7	18.1
8033	79.8	74.9	4.9
8002	82.1	78.5	3.6

*The letter R and B refer to the red and black scoria used in the potting mix.

as well as expected in spite of periodic soil drenches for disease control. Only after tests showed extremely low air pore space in the medium did the grower mention that a new batch of peat costing fifty cents a bale less than that previously purchased was used in the medium. Examination of the peat bales disclosed that the peat was indeeed extremeley fine textured approaching a muck-like consistency. Use of the cheaper peat was discontinued and a good grade substituted in future batches of mix. Watering no longer became a problem and soil drenches other than for routine purposes were virtually eliminated. As seen here, price isn't always the best criteria for determining economics of media preparation.

Even potting media for cactus plants can vary tremendously when, supposely, the same formulations are mixed at two different nurseries. Table 4 shows the variation which actually did occur when this took place. Sources for ingredients were almost identical for both media. The finished mixtures didn't even look the same. By watching the mixing operations, it soon became apparent that there was just cause for concern. In the preparation of mixture 8008, the tractor operator continually rode the machine back and forth across the edges of the pumice pile in the mixing process until much of the pumice so treated was reduced to a fine powder. In addition, there was little similarity in the on the total contents of the skip loader bucket which was being used to measure the relative

TABLE 4. COMPARISON OF CACTUS POTTING MIXTURES AT TWO NURSERIES

CODE	PERCENTAGE OF INGREDIENT		
	FIR BARK	PEAT	PUMICE
8010	25.0	25.0	50.0
8008	25.0	25.0	50.0

	TOTAL POROSITY % BY VOLUME	WATER CONTENT % BY VOLUME	AIR FILLED POROSITY % BY VOLUME
8010	81.6	60.4	21.2
8008	79.1	69.7	9.4

percentage of ingredients. Consequently, any similarity between the theoretical ingredient balance and that which existed was purely coincidental. Remedial action in replacing the person doing the mixing at this nursery corrected the problem. Eventually, both mixtures were quite similar in appearance and cultural requirements.

It is obvious from the foregoing example from the foregoing examples that peat isn't just peat, pumice isn't just pumice, soil isn't just soil or, for that matter, any ingredient used in potting media is not always the same quality just because the name is the same. Ingredients can vary greatly from one source to another or from one batch to another. Reproducibility of potting media batches can be accomplished mainly through vigilance in examination of ingredients on delivery and insuring good quality control of the mixing process itself.

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