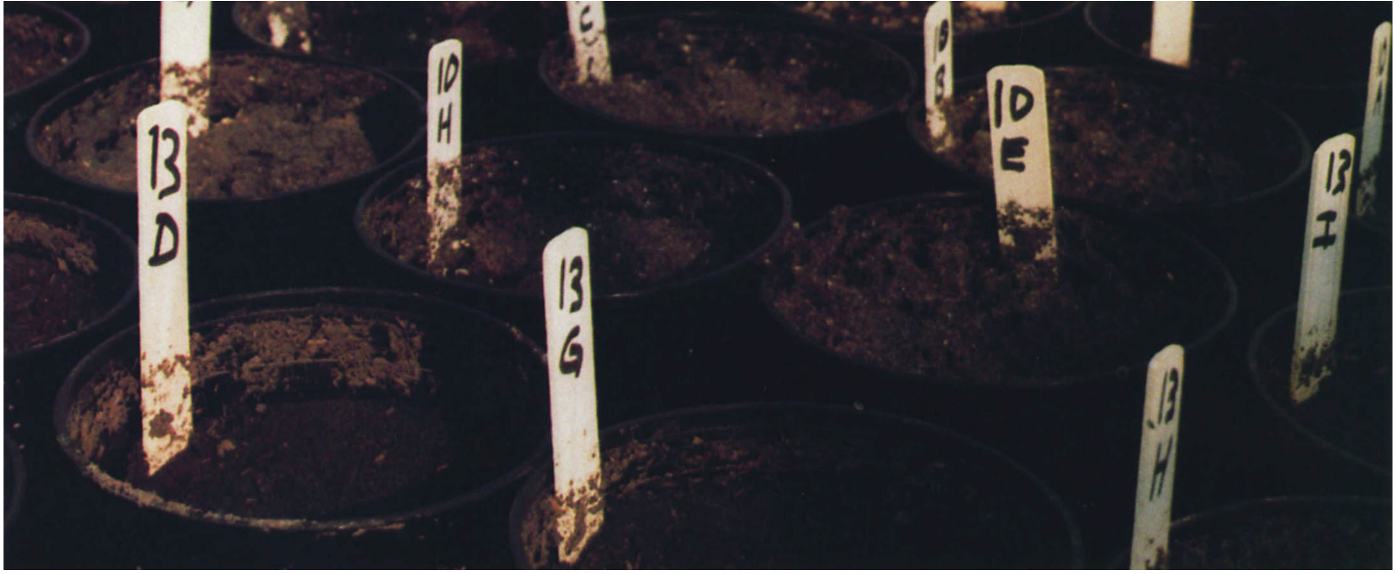

Potting soil label information is inadequate

Dennis R. Pittenger

Key properties are not listed

The chemical and physical properties of a potting mix determine its performance. Physically, to sustain plant growth, the mix must hold large quantities of water in a limited volume and yet maintain a high volume of aeration. Since soil in a container does not behave the same as in the field, potting mixes are typically formulated with a high percentage of bulky organic materials such as bark, wood chips, peat, or compost. These materials hold varying amounts of water and also create pockets of air in the mixture. Mixes usually contain additional nonorganic materials such as sand, vermiculite, or perlite, which provide additional aeration and structure.

Research has also shown that, chemically, quality potting soils must be low in soluble salts, slightly acidic (pH of 5.0 to 6.5), and capable of holding essential nutrients for plant growth.

Potting soil mixes sold through retail garden supply outlets in California vary widely in their performance as growing media. Consumers have frequently reported unsatisfactory results with many mixes despite state labeling regulations designed to ensure that products are properly identified and are of high quality. Manufacturers are now required to place on the product label the names of the ingredients in decreasing order of volume.

This study was conducted to determine whether the labeling information is actually useful in predicting the performance of potting soil mixes before they are purchased and used. Single bags of 15 widely available packaged potting soil mixes were purchased at random from various retail garden supply outlets in southern California during the fall and winter of 1984 (table 1). Their relevant physical and chemical properties, plus their ability to support seedling growth, were evaluated.

Physical properties

It is generally agreed that adequate soil aeration, reasonable water-holding capacity, and free drainage are essential physical qualities of an acceptable potting soil. Aeration is thought to be the most important physical property for most situations.

Since standard methods for determining many of the physical properties of soils are not well suited to testing potting soil mixes under actual use conditions, simplified methods were developed to provide accurate, replicated measurements. The procedures were carried out in standard warm greenhouse conditions and were devised for use with 1-gallon or smaller plastic pots, with each pot constituting one replicate.

The study included six 3-quart pots of each mix. Each pot was filled loosely to the rim with a mix, then tapped sharply on the bench five times to settle the material. Filled pots were watered thoroughly and the ease of wetting was noted.

The pots were then watered three times a week for four weeks to allow compaction. After the final watering, the pots were placed in a saturation tray for 24 hours, weighed, allowed to drain for 48 hours, and reweighed as a means of calculating pore space and container capacity volumes. The exact volume of potting soil in each container was used to determine volume ratios associated with physical properties of the potting soils. The infiltration rate was then measured immediately by observation of the time required for 200 ml (nearly 7 fluid ounces) of water to move through containers after they were saturated.

Finally, a core sample of known volume was taken from the center of each container, then oven-dried and weighed so that the dry weight of the total soil mass as well as the bulk density could be calculated for each potting soil.

Results for the total pore space determination indicate that four soils had ideal levels (mixes 3, 4, 11, 13), nine other products had moderately high levels (mixes 1, 2, 5, 6, 7, 8, 9, 12, 14), and the rest (mixes 10, 15) had only moderate levels. The volume of air at container capacity, which is the amount present after watering and subsequent drainage, was in the suggested optimum percentage range in mixes 1, 3, 4, 7, 8, 11, 12, 13, and 15, but less than optimum in the other six products.

Container capacity, which is an estimate of the upper limit of available moisture of soil in a container, was moderately high to high for each of the mixes evaluated. This finding suggests that each product could hold an adequate amount of moisture.

With the exception of rates for mix 5, all of the infiltration rates calculated by these procedures were extremely high. It was observed, however, that potting mixes 1, 6, 7, 8, 10, and 15 were considerably less permeable than the others and that mix 5 had very poor relative infiltration.

The percentage of water significantly affected the handling of mix 7. This mix, which was sold by weight, was needlessly high in water, and was much more difficult to handle out of the package.

In addition, initial wetting of the mix was a problem in products 9, 10, and 11, which required several irrigations to become thoroughly wet.

In this test, potting soil mixes with fir bark or forest materials as the primary ingredients more consistently approached or exceeded suggested minimum standards of the essential physical qualities than did those with other organic materi-

TABLE 1. Potting soil mixes evaluated

Mix ID	Name of mix	Manufacturer	Package ingredient statement*
1	Supersoil	Rod McLellan Company San Francisco, CA 94080	Fir bark, redwood, Canadian peat, pure sand
2	Perma-Gro All-Purpose Potting Soil	Mfg'd for Nurseryland by Jungle Growth Products, Inc. Torrance, CA 90503	86% composted forest materials, 14% perlite and sand
3	Bandini Potting Soil Formula 105	Bandini Fertilizer Company Los Angeles, CA 90023	Finely ground fir bark, Canadian sphagnum peat moss, sterile horticultural sand
4	Good Earth Potting Soil	Wilbur-Ellis Company E. Irvine, CA 92650	Not listed (probably wood products, sand, perlite)†
5	Vita-Hume Outdoor Planting Mix	Anderson Organic Division of Hyponex Corporation Fort Wayne, IN 46801	Humus, peat, other ingredients essential to organic gardening
6	UniGrow Potting Soil	L&L Nursery Supply, Inc. Chino, CA 91710 Fremont, CA 94536	Redwood sawdust, ground fir bark, washed sand, peat moss, vermiculite
7	Power-O-Peat (sold by 20 lb bag)	Power-O-Peat P.O. Box 956 Gilbert, MN 55741-0956	75% organic peat moss, 15% perlite, 10% vermiculute
8	Gromulch Planting Mix	Kellogg Supply, Inc. Carson, CA 90745	Forest products and composted centifuged sewage sludge
9	Unigrow African Violet mix	L&L Nursery Supply, Inc. Chino, CA 91710 Fremont, CA 94536	Redwood sawdust, ground fir bark, peat moss, washed sand, vermicuite, perlite
10	Hyponex Professional Mix Potting Soil	The Hyponex Co., Inc. Copley, OH 44321	Canadian sphagnum peat moss, peat humus, vermiculite, perlite, charcoal
11	Jiffy Mix	Care Free Garden Products P.O. Box 383 W. Chicago, IL 60185	Sphagnum peat moss and vermiculite
12	Jungle Growth House Plant Potting Mix	Jungle Growth Products, Inc. 14107 Crenshaw Blvd. Hawthorne, CA 90250	90% organic materials, 10% aeration and moisture retention materials (shredded bark or wood) plus perlite
13	Roger's Potting Soil Mix	Roger's Gardens Newport Beach, CA 92660	Forest products and compost with N, Ca, K, P, Mg, and Fe added
14	Black Magic House Plant Mix	Black Magic Products 8137 Elder Creek Road Sacramento, CA 95824	Forest products, perlite, peat moss, charcoal
15	K-Mart Potting Soil	Western Garden Marketing, Inc. Tempe, AZ 85283	Forest compost, perlite, sand

* Listed in order of decreasing volume.
† Estimated by visual inspection under magnification.

TABLE 2. Important properties of potting soil mixes

Mix ID	Total pore space	Air @ container capacity	Water	pH	EC	Organic matter	Nitrate (NO_3)	Ammonium (NH_4)	P	K
	% volume	*% volume*	*%*		*dS/m*	*%*	*ppm*	*ppm*	*ppm*	*ppm*
1	79	12	34	6.1	2.8	39	355	6	201	516
2	66	9	135	5.9	0.85	97	1	43	61	694
3	89	13	67	4.3	4.0	50	360	32	173	1,052
4	87	19	38	6.7	6.0	51	2	25	165	3,000
5	71	6	80	4.4	9.1	50	16	43	10	152
6	68	8	49	6.2	2.1	41	3	32	206	556
7	77	12	248	4.4	0.3	93	49	6	9	72
8	75	13	84	4.9	11.5	45	1,770	359	150	1,072
9	73	10	59	6.4	1.0	38	4	23	106	364
10	58	9	67	4.5	9.2	52	28	61	10	200
11	85	13	91	5.8	1.8	48	710	21	53	1,060
12	67	12	121	6.7	1.6	95	8	407	143	1,152
13	88	20	164	7.2	1.4	90	9	27	190	1,128
14	67	9	152	7.5	0.7	88	6	37	38	2,560
15	60	12	87	6.3	1.4	68	68	261	18	892

als as primary ingredients. This finding does not suggest a cause-and-effect relationship, however, since these tendencies were not observed for all products evaluated. In fact, most of the products demonstrated at least satisfactory overall physical properties with the possible exceptions of mixes 5, 6, 7, 8, 10, and 15. The results do suggest that consumers may have some confidence that a high percentage of bark or forest materials in a given mix is an indication of satisfactory physical characteristics.

Chemical properties

Samples of each mix purchased were analyzed for pH, soluble salts, percent organic matter, percent water, and concentrations of important nutrients. All measurements were by the standard methods used by the University of California Cooperative Extension Soil, Water, and Plant Analysis Laboratory.

The range in chemical properties was quite wide. Unlike results of the physical analysis, there did not appear to be any link between the primary ingredients and the respective chemical properties in the potting soils. The only predictable link was that of the sewage sludge and a correspondingly high salt content of mix 8, since processed sewage sludge often contains concentrated salts.

Several mixes (3, 5, 7, 8, 10) had pH measurements well below the reported acceptable range for growing plants in artificial media, and two products had pH values above 7.0. Soluble salts were at significantly higher levels than the generally accepted maximum of 2.0 dS/m in six mixes, and in four products were at levels that could cause serious injury to many plant species (mixes 4, 5, 8, 10).

Concentrations of the nutrient ions sampled indicated that more than one ion contributed to the high salts in a given mix. The overall nutrient status of these potting soils varied widely from deficient to nearly excessive. Of particular importance were the ranges of the macronutrients nitrogen, phosphorus, and potassium.

Organic matter percentages ranged from about 38 to over 95 percent with a majority of the mixes having over 50 percent concentrations. There was no consistent relationship between the percentage of organic matter and pore space in these mixes.

In summary, a number of the products evaluated showed unsatisfactory values for more than one chemical property (mixes 3, 5, 8, 19). Soluble salts and pH levels were the primary problems. Since these conditions cannot be correlated to stated mix ingredients, it is likely that the

Seedling growth in the different potting mixes varied widely. Some developed poor root systems and, in many instances, there were not enough roots to permit removal of a soil/root plug intact from the test pot.

poor chemical performance results from the manufacturer's total formulation process and not from the raw ingredients listed on the package.

Germination and growth

Samples of each potting soil mix were placed in 24 one-inch cells (four replicates of six cells) in a Speedling flat, and one tomato seed (cv. 'Bigset') was placed in each cell for observation of germination and growth rates. A sample of the standard UC greenhouse soil mix (50 percent sand, 25 percent shredded bark, 25 percent Canadian peat moss, plus a nutrient mix) was included in this trial for comparison.

The flats were overhead-watered, covered with clear plastic, and placed in a warm greenhouse. As germination proceeded, the plastic was removed, and the flats received overhead irrigation of tap water as needed for the remainder of the experiment. Germination was recorded after 14 days. After one month, plant shoot lengths were measured and overall seedling and root-system vigor evaluated.

Germination percentages ranged from 46 to 92 percent (table 3). This lot of seed had 83 percent germination in a standard seven-day germination test, and half of the mixes evaluated met or exceeded the standard. The high salt content of mixes 8 and 9, surprisingly, did not reduce the germination of tomatoes, and neither did the low pH of mixes 7, 8, and 10. This suggests that the salts were readily leached and that tomato germination was not adversely affected by low pH.

Seedling growth varied widely. At the end of the one-month period, all the seedlings appeared somewhat deficient in nitrogen. The plants in mixes 2, 5, 7, and 10, however, appeared to have more than just a nitrogen deficiency, because they showed a great deal of purple coloration as well. Seedlings from mixes 2, 5, and 14 developed poor root systems, and in many instances, there were not enough roots to enable removal of a soil/root plug intact from the cell. Plants in mixes 12, 13, and the UC mix developed satisfactory root systems, while those in the remaining mixes developed excellent, vigorous roots. Good plants developed in mix 6, even though aeration and infiltration were relatively low. This mix had nearly optimum pH, salts, and phosphorus levels, which may have maximized the plants' capabilities under less than ideal soil physical conditions.

There was some indication of a link between root development and the air at container capacity for a given mix, as can be seen when comparing the plant growth in mixes 2, 5, and 14.

Overall, 11 of the potting soil mixes and the UC mix produced satisfactory tomato transplants. Several factors in both the physical and chemical properties of these mixes appear to be responsible for the outcome, but no consistent relationships between ingredients and seedling development could be determined. Some of the mixes with less than optimum ratings of important properties (3, 5, 6, 8) produced acceptable tomato seedlings. From this very limited growing test, one cannot determine how seeds and seedlings of other crops would develop in these mixes, nor can the performance of other species that would be transplanted into one of these mixes be estimated. It is reasonable to assume that the use of mixes with less than optimum pH, aeration, or drainage characteristics and with high soluble salts would result in poor growth of a wide range of plant species under most conditions.

TABLE 3. Germination and growth of tomatoes in potting soil mixes

Mix ID	Germination @ 14 days	Average seedling height @ 1 month	Overall seedling vigor rating*
		cm	
1	79	10.6	Excellent
2	46	6.0	Poor
3	67	10.1	Excellent
4	79	6.3	Poor
5	71	6.7	Satisfactory
6	50	9.4	Good
7	92	7.1	Satisfactory
8	83	8.6	Good
9	83	6.3	Poor
10	92	8.1	Satisfactory
11	67	8.6	Good
12	67	6.3	Satisfactory
13	83	6.9	Satisfactory
14	87	4.7	Poor
15	83	7.6	Satisfactory
UC mix	83	6.8	Satisfactory

* Includes shoot and root development.

Conclusions

The results of this study are based on single purchases of products that may not represent their average quality. However, the findings do describe the actual quality control problems confronting consumers and justify the following conclusions and recommendations.

There is limited evidence suggesting that a consumer could predict the physical suitability of a potting mix by knowing the types of ingredients, but there are no consistent relationships between the chemical properties or seedling development and the ingredients. In this study, pH, soluble salts, and air at container capacity appeared to be the properties that determined whether or not a mix was suitable. Since none of these attributes could be related consistently to the ingredients used, information currently required on package labels is inadequate for a consumer to use in predicting the performance of a potting soil.

Accurate decisions on suitability can only be made if one also knows the pH, soluble salts, and air at container capacity. It is recommended that manufacturers include this information as well. In the interim, consumers are recommended to:

- Select mixes high in bark, forest materials, or sphagnum peat plus vermiculite.
- Thoroughly leach any potting soil at least three or four times before placing seed or plant material in the mix. Leaching will reduce soluble salts to acceptable levels in most mixes.
- Fertilize with a soluble fertilizer according to the manufacturer's directions within two weeks after plants are growing in new potting soil to replace leached nutrients and those taken up by the plants.

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