rect it. Reception by the formulators has been most gratifying, each welcomed our report and our suggestions for improvement in formulation where advisable.

Through these tests and our work with the formulators it is hoped that the industry will regulate itself so that all mixes produced are high quality and are consistent.

PEAT, PESTS, AND PROPAGATION

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Peat has been a standard component of propagation and growing media for many years. Bunt (3) describes peat as by far the most widely used material for making plant growing media. Its water-holding capacity is valued in propagation. In growing media, its nutrient holding capacity, "buffering" capacity against rapid pH changes and excessive soluble salts accumulation, and ability to improve aeration are additionally useful.

Peat is far from being a uniform product (3,11). Nursery and greenhouse growers experience variable performances with use of different peat sources.

Varying physical and chemical properties of peat depend primarily on the nature and origin of the plant remains of which it is composed and their degree of decomposition (14). Commonly used peats consist mostly of decayed sedges, mosses, reeds, and grasses. Different types of peat, in varying states of decomposition, occur at specific locations throughout the world, mostly in the boreal climates of the Northern Hemisphere — Canada, Scandinavia, and Russia.

Contaminants also contribute to the variable results in using peat and affect its value. Resulting disease and pest problems may occasionally occur to adversely influence plant performance.

Contamination of Peat. Increased concern with contamination of peat has been expressed in recent years (2,8,10,12). Although some products are labeled "sterilized," "no fungi," or "weed free," peat has been detected as a source of pathogenic fungi, weeds, and nematodes (1,2,4,8).

Peat, as a source of pathogens and pests, is a controversial subject. Peat has traditionally been regarded as being relatively sterile and some have questioned the need to be concerned

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about its possible contamination. Others suggests peat be sterilized prior to use for propagating and growing plants (4,5,10,13).

Only weed, insect, and nematode problems with peat will be further discussed here since pathogenic fungi are presented in another discussion.

Weeds Associated With Peat. A group of weeds is consistently observed in Western Oregon nursery and greenhouse operations when peat is used. While peat cannot positively be identified as the source, circumstantial evidence indicates it is the source for at least some of them.

Most common of this group are common chickweed (*Stellaria media* (L.) Cyrill.), sheep sorrel (*Rumex acetosella* L.), yellow wood-sorrel (*Oxalis stricta* L.), and several grasses, including annual bluegrass (*Poa annua* L.).

Several other weeds are found in media made with peat, and are suspected as often coming from the peat. Included are little western-bittercress (*Cardamine oligosperma* Nutt. var. *oligosperma*), red dead-nettle or henbit (*Lamium purpureum* L.), and speedwell (*Veronica* L. spp.). Common groundsel (*Senecio vulgaris* L.) may be among these, but this is difficult to ascertain because of wind distribution of its seed. Pearlwort (*Sagina* L. spp.) is reported as probably coming from peat by a California nurseryman (1). Willow (*Salix* L. sp.) seedlings were reported by an Oregon nursery grower as probably coming from the peat in which rhododendron liners were propagated. Kim (7) has found weed seeds in peat, but has not identified the species.

All of these weeds are widespread in their distribution. Some are of European origin and have become widely distributed throughout North America. Others are native to the Pacific Northwest or the larger Pacific Coastal region. Much of the peat used by Western Oregon growers comes from British Columbia bogs. These weeds are common to the Canadian province as well (6), making infestation at the source site a possibility.

Actual number of weed seeds in a bale of peat appears to be relatively small. The problem increases as these few seeds germinate, grow, reproduce, and increase the seed supply. Nursery and greenhouse conditions are nearly ideal for growth and increase of these weeds.

Insects and Peat. Few, if any, reports implicate peat with insect problems. Heller (5) is concerned with the potential for infestation of fungus gnats (Mycetophilidae) in peat and peat mixes in open storage. Fungus gnats are attracted to moist organic media. He suggests sterilization of peat prior to use. Fun-

gus gnat larvae, feeding on plant roots, can be a serious problem, particularly with greenhouse crops. They are capable of rapid reproduction and population growth. Their control requires persistent effort. Fungus gnats are common, often numerous, in Western Oregon greenhouses. It is likely that a peat medium could quickly become infested, even with gnat-free peat.

The Nematode Potential. Free-living non-parasitic nematodes have been found in peat (8). While these were not considered a potential problem, perhaps they serve as a warning that peat might be a source of parasitic nematodes.

Possible Sources of Contamination. Any time peat is exposed to wind, water, or soil, contamination is possible. There are numerous possibilities during the harvesting, distribution, and use of peat for this to occur.

Peat removal methods have changed considerably in recent years (3,9,14). From the hand methods of earlier years, excavation of peat became mechanized with use of draglines, scoops running on endless cables, power shovels, clamshell dredges, and specialized equipment. Bogs were first drained, a process requiring up to five years. Occasionally the equipment was on scows floating on a lake or pond, in which case the bog was not drained.

The long time needed to drain a bog, and other factors, caused further changes in harvesting many Canadian peat bogs (9). "Hoverbarges," supported by an air cushion above the bog surface and with a large clamshell crane mounted on each, scoop out bites of peat from the bog. The peat is dropped into hoppers on the barge where peat and debris are separated with water pressure. Peat is then piped from barge in form of a slurry to a dewatering station at the edge of a bog, dewatered, and trucked to a nearby processing plant. The peat is stockpiled, dried, sometimes ground, and bagged at the processing plant.

The many opportunities for contamination during these harvesting processes are apparent. There is some speculation that newer wet harvesting methods may increase the potential or infestation of pathogenic fungi. Contaminants may possibly enter bogs prior to peat removal. Wind and water-distributed weed seeds, fungal spores, nematodes, and insects could be present in peat before harvest. From this it seems logical that peat from deeper in the bog may be more free of contamination than that from surface layers.

There are ample opportunities, and concerns, for contamination of peat at the nursery and greenhouse sites where it is used (12). Broken bags, open storage, unsanitary conditions, and other situations may contribute to this problem. Commer-

cial growing mixes containing peat and sold by many industry supply firms are reported to often contain pathogens, apparently contaminated during the mixing progress (7).

CONCLUSIONS

It should not be implied from the foregoing that peat is an inferior material or inferior to other materials as a propagating or growing medium or medium component. Peat continues to be an important and useful product to the nursery and greenhouse industry. The growing concern with peat quality may, in part, be due to more available information and higher production standards than in earlier years.

Most reports indicate relatively low levels of contaminants when they do occur. This, however, does not eliminate the need for concern. A low level of contamination may grow into a serious problem.

It is important that peat be properly handled and used to avoid contamination. Sterilization of peat may be beneficial and economical for many production operations. Without sterilization, peat can be a source of disease, weed, and insect problems.

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PATHOGENS ASSOCIATED WITH PEAT MOSS USED FOR PROPAGATION[1]

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The use of peat moss as a constituent of media for growing and propagating plants is an old and well accepted practice. Although its properties may vary slightly, depending on its origin, peat moss generally has a high moisture-holding capacity, a low pH and contains a small amount of nitrogen (3). Its primary function as an additive to propagation media is to increase moisture-holding capacity.

Introduction of plant pathogens in peat moss has received little attention among plant propagators. Kim, *et al.* (4) isolated several pathogenic fungi from foreign and domestic sources of peat moss and stated that peat may serve as a vehicle for the entry of plant pathogens from foreign countries. Their observations also suggest that plant propagators might introduce pathogenic organisms into cutting beds, seed flats, etc. through the use of contaminated peat moss.

An example of such contamination occurred several years ago in Oregon when *Penicillium spp.* infected the basal portion of rhododendron cuttings and caused serious losses. Infected cuttings developed dark brown discoloration of the wood at the base of the cutting (Figure 1). Sporulation of the fungus on the decayed wood produced a powdery, bluish-green deposit.

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[1] Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

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