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Peat and Swamp Muck For Soil Improvement in Connecticut

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PRACTICALLY every town in the State has numerous swamps that contain deposits of more or less decomposed organic matter commonly known as peat or muck. These range in size from less than an acre to several hundred acres. The humus deposits vary in depth from 1 or 2 feet up to 30 or 40 feet. No definite measurement has been made of their exact extent. However, from detailed surveys in a number of towns, and general reconnaissance throughout the State, it is conservatively estimated that there are approximately 50,000 acres of fresh water swamp land in Connecticut. Assuming that the average depth of these deposits is but 6 feet, a very conservative figure, the total volume of this highly organic material is practically one-half billion cubic yards.

The potentialities of this resource have been largely undeveloped. As a fuel reserve it has considerable value, since it represents the equivalent of many millions of tons of coal or cords of wood. However, it will probably never be used to any extent for such a purpose. The greatest advantage can be derived from its use in improving the soils of farm, garden, park and lawn areas. These humus deposits are more than sufficient to supply a 2-inch dressing to the entire land area of the State. Many home-owners have been willing to pay five dollars per cubic yard for such material. A resource with a possible sale value of two and one-half billion dollars is rather staggering to the imagination, especially since it represents areas of practically worthless swamp land, carried on the assessor's books at considerably less than a quarter of a million dollars!

SWAMP MUCK or peat was used for the improvement of poor sandy and gravelly soils in some sections of Connecticut at least as early as 1800. Professor S. W. Johnson, first Director of this Station, published an extensive treatise on the subject in 1858, with data on samples from 23 farmers who were then using such materials on their soil. The most popular practice was to mix or compost one part of moist peat with two or three parts of stable manure, and a number of farmers considered that such a mixture was as effective as the straight manure.

The use of swamp deposits for soil improvement probably increased until about 1870, when farming the land was at its zenith in this State. The past two generations of farmers have not considered it practicable to dig out their swamp muck and haul it to the fields, and the practice has been almost entirely abandoned.

Soon after the World War dealers in gardeners' supplies began the sale of baled dry moss peat imported from northern Europe, chiefly from Germany and Sweden. This material found a ready market for use in improving the physical conditions of garden, lawn and greenhouse soils; as a mulch under shrubbery and over flower beds, and for similar purposes. The transportation and selling costs of baled moss peat warranted retail prices ranging from two to three dollars per bale of 150 to 170 pounds, containing from 130 to 150 pounds of actual organic matter. The consumer has paid in the neighborhood of two cents a pound for organic matter in this type of material. Such a cost was prohibitive to the farmer, even though reasonable to the home gardener, the commercial floriculturist or the landscaping contractor. The minimum effective application that could make any appreciable contribution to the humus content of an acre of soil, normally containing at least 40,000 pounds of organic matter, would cost hundreds of dollars.

The popularity of moss peat during recent years has caused a renewed interest in the development of the local swamp deposits. A few individuals or concerns are now marketing moist swamp peat, frequently designated as "humus". Several landscaping contractors are supplying their needs by working swamps that they own or lease. Such material is usually excavated from the swamp by power shovel or drag line machinery, piled for several months to remove the surplus water, shredded and passed through a coarse screen.

The product thus obtained is still quite moist, usually containing from 60 to 80 percent of water. In such condition, it is quite bulky and rather heavy in proportion to the actual dry substance it represents. Shredded and screened moist swamp peat of average quality weighs approximately 1200 pounds per cubic yard, representing about 300 pounds of dry material and about 225 pounds of actual organic matter. However, as will be shown later, there is much variation from the above figures for individual lots. Retail prices are largely dependent upon the quantity required by the purchaser and the distance from the location of the swamp to the point of delivery. If the price is to be comparable to baled moss peat as sold during recent years, from four to five dollars per cubic yard would roughly correspond to baled "peat moss" at two dollars and a half to three dollars per bale. It is probable that transportation costs for such a commodity would necessitate delivered prices greater than the above if the distance to point of delivery exceeds 20 to 30 miles.

There has been some use of peat or muck brought into the State from distant points in the United States and Canada. Such material is frequently brought to a less moist condition by partial drying and made less bulky by packing tightly in crates or bags before shipment. However, it is not fully air-dry or packed in bales as the German or Scandinavian products are.

Characteristics of Various Types of Peat

PEAT deposits are variously classified by different investigators. However, the types recognized by Dachnowski-Stokes* are adequate for most purposes.

Sedimentary peat. This is composed of accumulations on the bottoms of open ponds or shallow lakes; soft, oozy and structureless; finely textured and plastic when wet, hard and horny when dry. Such peat is often found under other types, representing an earlier, open water stage in the development of the swamp from a pond. The deposits are usually too difficult to work and to dry to a mellow physical state for practical consideration. Occasionally a drained lake bed provides easy access to sedimentary material of a relatively high humus content, suitable for local use in soil improvement. However, brooks draining into many lakes and ponds supply mud chiefly of inorganic (mineral) type, greatly adding to the weight of the deposit without contributing to its value as a soil amendment.

Reed or sedge peat. When a pond becomes so filled with sedimentary peat that open water disappears, marsh vegetation, composed chiefly of reeds and sedges, may become established over the surface. Partially decayed residues from saw grass, cat-tail rushes, reeds and reed-like grasses, are usually more or less spongy and porous and of dark brown to black color, depending upon the degree of disintegration of the original plant fibers. A relatively small area of fresh water marsh land is to be found in Connecticut, and most of the present occurrences of reed or sedge vegetation are either associated with the salt marshes or are subject to flooding by the overflow of large streams that build up silty sediments so rapidly that the deposit is comparatively low in actual humus content. However, woody peat, as described in the following section, is often underlain by older layers of reed or sedge peat.

Woody peat. Most of the poorly drained areas of the State occur under forest cover, composed of species that are capable of growing in material that is practically saturated with water during most of the year. Red maple (soft or swamp maple) is now the dominant tree species on most Connecticut swamps. It is frequently in association with elm, yellow birch, and black ash, with blue beech, pepperidge and alder represented in the understory and shrubby growth. A diversified group of small shrubs, perennial herbs, ferns and mosses compose the ground cover under such woodland. This is the most common type of swamp peat in Connecticut.

When the State was first settled, cedar was the dominant tree on many swamps. However, this valuable species largely disappeared except in a few isolated locations, as a consequence of frequent logging operations. There are occasional swamps still dominated by other coniferous trees, such as tamarack and black spruce.

Under these forest conditions, the principal sources of organic matter are the residues of the decay of fallen logs, branches, leaves and roots. The material is often coarse and poorly disintegrated. However, many

* Dachnowski-Stokes, A. P., 1933. Grades of peat and muck for soil improvement. Circular 290, U. S. Department of Agriculture.

gradations occur; soft, practically structureless and nearly black deposits are often to be found within a few inches of the surface in numerous woodland swamps. This is especially true when the residual material is relatively rich in calcium and of only a moderate degree of acidity (5.0 to 5.8 pH). The peat originally formed under white cedar and associated species is commonly deficient in calcium and quite strongly acid (3.8 to 4.6 pH). The more acid peats are usually deeper brown in color and of more fibrous texture. Some deposits show frequent layers that are rather felt-like in appearance due to the closely matted, lignified fibers that have resisted decomposition.

Moss peat. The predominant vegetation that contributes to the final stage of peat formation in regions of continuously cool and moist summers is likely to be composed of mosses, chiefly of various species of Sphagnum. Trees and woody shrubs may be absent entirely, or grow so sparsely that they supply an insignificant residue. Such peat bogs may even occur on slopes where there is seepage water from adjacent higher ground. The center of the bog builds itself up to a higher level than the margins, because great volumes of the Sphagnum residues accumulate over long periods of time, with comparatively little shrinkage from decay. These convex-surfaced "high moors" attain their greatest development in northern Germany and in the Scandinavian countries of the Baltic Sea region. The peat from such deposits is unusually fibrous, spongy and resistant to decay, even after prolonged contact with soil under good conditions of drainage and aeration. It is so porous that it can be thoroughly air-dried without much difficulty. However, even when air-dry, it contains from 10 to 20 percent of water. Its fibers do not readily crumble to form objectionable dust during shipment. The material can be compactly baled in packages of uniform size and reasonably consistent dry weight and composition. It can be shipped in the holds of ocean liners at very little expense, since it serves to fill up excess space and prevents the shifting of other cargo. Until the outbreak of the present European war, most moss peat used in the northeastern states was thus imported. However, no further shipments can be expected until the restoration of peace-time conditions.

Moss peat also occurs in Maine and other northern states, and in Canada. However, the typical "high moor" fibrous peats are usually rare and found in difficultly accessible locations. The disappearance of German and Swedish peat from the market may encourage their development, but the prices that the consumer can afford to pay for such material will probably not be sufficient to attract any considerable production of baled, dry moss peat on this side of the Atlantic.

Swamp muck. This term is rather loosely used by both agricultural scientists and farmers. It is most commonly applied to deposits of a very dark brown to black color, that are soft and mellow when moist, without a noticeable amount of fibrous or felty substance. As a rule, such material contains smaller proportions of organic matter than typical peats. However, there is no clear-cut distinction in this respect. In general, muck is less acid than peat under Connecticut conditions. Most of what is commonly called "muck" in this State really represents a well decomposed type of woody peat.

Comparisons of Common Peat and Muck Materials

Some peats and swamp mucks are usually considered on the basis of a cubic yard, in a moist state, while others are sold by the bale, crate or bag, in a more or less dry condition. Users must consider how much actual organic matter, nitrogen and water absorption they may expect from these various units of value. They should also be informed as to the approximate pH so that the suitability of the material for the kinds of plants to be grown may be considered. Such pertinent information is shown in Table 1, for representative lots of various peats and muck that have been examined at this Station.

Properties of Peat Affecting Soil Improvement

Moisture holding capacity. All peats have a very high capacity to absorb water as compared with mineral soils. One part of dry material is capable of soaking up several times its weight of water, ranging from 10 to 12 in case of the imported moss peats down to 4 to 6 times for the poorer grades of native swamp peat or muck. Thus it is readily possible to increase materially the moisture holding capacity of a poor sandy or gravelly soil by the incorporation of relatively small proportions of peat, (one-sixth to one-third) by bulk. A mixture of three volumes of sandy soil to one volume of peat contains from 50 to 100 percent more water when saturated than the sandy soil alone, on the basis of trials conducted at this Station.

Moisture retentiveness. Peat or swamp muck dries very slowly compared with mineral soil. Thus a sandy soil, after two or three weeks of dry weather at midsummer, may be reduced to a very low moisture content, 5 percent or less by weight, causing severe injury to plant growth. When mixed with peat in the proportions of three volumes of soil to one of peat, the soil may be made to retain from three to five times as much water after similar periods of drying. However, a considerable part of this moisture cannot be used by the plant. The addition of peat to the soil increases the relative amount of this unavailable water.

In our experiments 12 different peat and swamp muck materials were mixed with light, sandy soil, in the proportion of three parts of soil to one of peat or muck, and used in pot experiments under crop for a period of six months. At the end of this time tests were conducted with reference to their water holding capacity, in excess of unavailable water (wilting point). This has been computed in terms of gallons of water per 1000 square feet, assuming a depth of 3 inches of humus incorporation.

Six Connecticut peats gave increases in available water capacity ranging from 100 to 150 gallons per 1000 square feet, averaging 125 gallons. Reed, sedge and moss peats from outside the State ranged from 131 to 206 gallons, the highest value being obtained from imported moss peat. On this basis, a bale of dry moss peat is slightly more effective than a cubic yard of moist swamp peat.

After 20 days of exposure to uniform conditions of evaporation at normal summer temperatures in open cylinders of 3-inch soil depth, the untreated soil had dried to the wilting point. All treated soils still retained some available water. The six soils mixed with native peats ranged from

TABLE 1. COMPARATIVE DATA ON REPRESENTATIVE PEAT AND MUCK MATERIALS

Obtained from:	Type and source	Unit of value	Lbs. per unit of value, as received: Total weight	Dry matter	Organic matter	Nitrogen	Water holding capacity	pH	Experiment No.
Platt Seed Co., New Haven	Moss peat, Germany	bale	170.1	143.0	137.2	1.33	1497	3.8	...
J. F. Osmun, North Haven	Moss peat, Sweden	bale	172.0	142.6	141.0	1.35	1614	3.9	488
Landscaping Dept., Yale Univ.	Moss peat, Maine	2 bu. bag	121.0	58.4	55.0	0.53	582	4.1	487
Hi-Test Humus Co., Goshen, N. Y.	Moss peat, N. Y.	Cu. yard	901.6	386.9	351.9	8.56	2027	3.7	...
Platt Seed Co., New Haven	Saw grass peat, Fla.	200 lb. crate	200.0	154.4	140.6	3.46	1380	6.1	486
Am. Soil Sponge Selling Corp., N. Y.	Sedge peat, Mich.	100 lb. bag	100.0	42.5	40.5	0.78	248	4.1	489
W. P. White, Meriden	Sedge peat, N. Y.	Cu. yard	1120.0	350.0	256.5	8.40	1771	5.0	484
Brookside Nurseries, Darien	Reed peat, N. Y.	Cu. yard	1249.4	299.2	218.1	7.00	1544	6.0	483
W. P. White, Meriden	Cultivated reed and sedge peat, Conn.	Cu. yard	1475.0	476.4	355.8	14.30	2072	5.1	485
S. R. Holmes, Glastonbury	Sedimentary peat, Conn.	Cu. yard	1125.6	368.1	209.7	7.54	2102	4.7	482
Middeleer, Florist, Darien	Sedimentary peat, Conn.	Cu. yard	1485.0	502.1	423.2	10.54	1677	4.7	480
C. L. Sonnichsen, Madison	Woody peat, Conn.	Cu. yard	1274.8	401.2	335.5	5.61	2556	3.9	481
Henry Trumbull, Plainville	Woody peat, Conn.	Cu. yard	1181.8	293.6	259.6	7.60	1955	5.5	479
Tenedine and Sons, North Haven	Woody peat, Conn.	Cu. yard	1652.9	384.8	223.8	8.20	2340	5.6	478
Walter Schmidt, West Hartford	Swamp muck, Conn.	Cu. yard	1774.4	590.3	222.5	5.31	1888	5.6	...
Conn. Highway Dept., Portland	Swamp muck, Conn.	Cu. yard	1825.6	281.7	133.3	3.80	1583	5.8	...
Dominic Vignola, Hamden	Swamp muck, Conn.	Cu. yard	1635.2	797.6	169.2	5.40	1037	4.8	...

25 to 57 gallons, averaging 39 gallons, per 1000 square feet. As in total available water capacity, the commercial peats from outside the State were somewhat better, ranging from 44 to 119 gallons, the latter figure representing the dry moss peat treatment. Pertinent data from this experiment is shown in Table 2.

TABLE 2. EFFECTS OF VARIOUS PEATS IN INCREASED AVAILABLE WATER CAPACITY AND WATER RETENTIVENESS, SIX MONTHS AFTER ADDITION TO A SANDY SOIL

Experiment No.[1]	Rate of treatment[2] (per 1000 square feet of area)	Increased total available water capacity, gallons	Increased retention of available water after 20 days of drying, gallons
478	3 cu. yds.	150	31
479	" " "	132	25
480	" " "	125	56
481	" " "	100	31
482	" " "	101	44
483	" " "	175	56
484	" " "	163	44
485	" " "	144	56
486	600 lbs.	169	112
487	24 bu.	131	50
488	4 bales	206	119
489	1500 lbs.	200	69

[1] See Table 1 for identifications.
[2] Based on incorporation with a 3-inch depth of soil.

The above results indicate significant improvement in moisture conditions when the humus materials are applied to light sandy soils. On the other hand, loam soils of moderate natural organic matter content have greater available water capacities and are relatively less improved by corresponding treatments.

Rate of water absorption. Thoroughly dry peat takes up water with difficulty until the material becomes moist, after which it absorbs rapidly, in the fashion of a sponge. This is often observed when dry moss peat is top-dressed over a lawn or when moist peat becomes sun-dried upon spreading. A vigorous shower causes the particles of peat to drift together before they can absorb sufficient water to cause them to stick to the turf. When the peat is mixed with the soil, or has been incorporated into the turf after top-dressing, it is rarely so dry as to lose its ability to absorb water readily. Many soils are too slow in rate of water absorption to take up heavy rains during the summer, especially when there is any appreciable slope to the surface. Humus materials are effective in improving such conditions, except as noted above.

Soil tilth. Many soils that are mellow and easily worked when they are moderately moist are apt to become hard when dry. This is especially true of clay soils, but may also apply to rather sandy soils such as occur in Connecticut. Clay soils also tend to become so stiff or sticky when they are practically saturated with water that they cannot be plowed or cultivated. Organic matter is very effective in overcoming these unfavorable conditions of soil tilth. The addition of a humus material to a sandy soil that becomes hard when dry causes an improvement that may be readily observed. Preliminary tests conducted along this line, shown in Table 3, indicate that moist swamp peats from local sources are more effective for this purpose than dry moss peat, when used in equal bulk. The reason may be that the former furnish larger quantities of organic substance when applied in similar bulk.

TABLE 3. ESTIMATED EFFECTS OF PEAT ADDITIONS ON THE HARDNESS OF AN AIR-DRIED SANDY SOIL, SIX MONTHS AFTER TREATMENT

Experiment No.[1]	Rate of treatment per 1000 sq. ft.[2]	Estimated relative hardness (untreated soil=10)
478	3 cu. yds.	6
479	" " "	5
480	" " "	5
481	" " "	4
482	" " "	3
483	" " "	2
484	" " "	2
485	" " "	4
486	600 lbs.	4
487	24 bu.	4
488	4 bales	7
489	1500 lbs.	6

[1] See Table 1 for identifications.
[2] Based on incorporation with a 3-inch depth of soil.

Durability of organic matter. Organic matter added to the soil in the form of organic fertilizers, such as tankage or cottonseed meal, is rapidly decomposed. After contact with the scil during a summer season, only a very small percentage of residual humus, usually less than one-fifth the amount added, remains. Organic matter in animal manures is somewhat less rapidly consumed, but again the soil retains only a small percentage for more than twc or three seasons. Humus added to the soil as peat or muck is much more durable. It represents the decay-resisting residues that have accumulated in swamps, marshes and moors for many hundreds of years. In contact with the soil under favorable conditions of aeration, peat does rot away to some extent, but at a very slow rate in comparison with fresh plant and animal substances. Moss peat is especially durable. The humus of swamps and marshes that have been drained and cultivated for vegetable crops for some time is usually in a more active condition and tends to disappear more rapidly. However, the physical benefits resulting from the addition of all classes of peat and muck may be expected to last for several years after the treatment.

Many persons have an exaggerated idea of the relative increase in soil organic matter to be expected from a given humus treatment. A loam soil of normal depth and organic content, under Connecticut conditions, already contains natural humus equivalent to at least 6 cubic yards of moist swamp peat or to 12 bales of dry moss peat per 1000 square feet of

area. On such a soil we can rarely afford to use a sufficiently heavy treatment to make a substantial increase. However, if we are considering a light sandy soil containing only half as much organic matter to start with, it is possible to build it up to a reasonably favorable level at a cost that is practicable for medium or small-sized lawns and gardens, at current commercial prices. The increased organic matter content contributed to a sandy soil, poor in humus, resulting from peat treatments is shown in Table 4.

TABLE 4. EFFECTS OF VARIOUS PEATS IN INCREASING ORGANIC MATTER CONTENT OF A SANDY SOIL, SIX MONTHS AFTER TREATMENT

Experiment No.[1]	Rate of treatment per 1000 sq. ft.[2]	Organic matter content of untreated soil %	Organic matter content of treated soil %	Increased organic matter content of treated soil %
478	3 cu. yds.	1.91	3.65	1.74
479	" " "	"	4.38	2.47
480	" " "	"	6.14	4.23
481	" " "	"	4.98	3.07
482	" " "	"	3.99	2.08
483	" " "	"	4.41	2.50
484	" " "	"	4.30	2.39
485	" " "	"	6.03	4.12
486	600 lbs.	"	4.68	2.77
487	24 bu.	"	3.47	1.56
488	4 bales	"	3.24	1.33
489	1500 lbs.	"	5.03	3.12

[1] See Table 1 for identifications.
[2] Based on incorporation with a 3-inch depth of soil.

Nitrogen Content. Peat and muck materials contain considerable amounts of nitrogen, ranging from less than 1 percent, in case of moss peat, to approximately 3 percent in good grades of "saw-grass" peats, such as those in Florida, on a dry weight basis. Connecticut swamp peats usually range from 1.5 to 2.5 percent of nitrogen.

The nitrogen contents of peats and of animal manures are of the same order of magnitude. However, the effectiveness of this nitrogen as a source of available plant food is quite another matter. A cubic yard of stable manure of good quality contains about 8 pounds of nitrogen. Of this, it may be safely estimated that 3 pounds will be effective as a fertilizer during the first season, and that at least half of the remaining 5 pounds will be released for plant growth during the following three or four seasons. In nitrogen availability studies with humus materials, six Connecticut peats averaged 8 pounds of nitrogen per cubic yard, identical to that of stable manure. However, less than one-fifth of a pound of nitrogen per cubic yard was found to be available for plant growth during the first six months. Nitrogen from imported moss peat was even less available. Results from these trials are shown in Table 5. It is obvious that as a source of nitrogen for plant food, such humus materials cannot be given serious consideration, since the nitrogen becoming available during one season from one cubic yard of peat can be purchased as a fertilizer for less than three cents!

Table 5. Availability of Nitrogen in Peats

Experiment No.[1]	Unit of value	Total nitrogen lbs. per unit of value	Nitrogen available for plant growth in one season. lbs. per unit of value
478	cu. yd.	8.15	.130
479	" "	7.56	.063
480	" "	10.54	.240
481	" "	5.61	.022
482	" "	7.54	.087
483	" "	7.00	.100
484	" "	8.40	.173
485	" "	14.30	.475
486	200 lb. crate	3.46	.057
487	2 bushel bag	0.53	.026
488	bale	1.35	.027
489	100 lb. bag	0.78	.026

[1] See Table 1 for identifications.

Other fertilizer constituents. Peat and muck materials are even less valuable as sources of phosphorus and potash. The actual percentages of P_2O_5 (phosphoric acid) usually range from 0.1 to 0.2 percent, and of K_2O (potash) from 0.6 to 2.0 percent, on a *dry weight* basis. However, the amounts per cubic yard or bale are quite insignificant, even if it is assumed that these constituents are available for plant growth. Careful plant growth tests under controlled conditions have indicated that some peats release a little more phosphorus or potash than others, but that poor soils cannot be improved from a plant food standpoint by the use of peat or muck in any reasonable amount. Such humus materials may render fertile soils less rich, from a chemical standpoint, by diluting their available constituents and by interacting to form less available components.

Minor elements. Peat residues, formed under conditions of constant saturation with water, are often deficient in copper, zinc or boron, elements required for plant growth in very small amounts. If a soil tends to be insufficiently supplied with these "trace" elements, the deficiencies may become more pronounced as a result of such humus additions. As a rule, moderately acid mucks containing considerable mineral matter are less likely to be deficient in such minor elements and may hold beneficial amounts of soluble iron and manganese. On the other hand, when first excavated from their water-logged condition, such muck may be harmful to plant growth as a consequence of too much soluble iron in the reduced (ferrous) state. This difficulty can be corrected by seasoning the material in piles for several months before use.

Acidity. As indicated in the descriptions of various types of peat earlier in this circular, there is a considerable variation in such deposits with respect to degree of acidity. This has an important bearing upon the utility of the material for soil amendment purposes. The strongly acid peats, such as moss peat and some swamp peats, ranging from 3.8 to 4.8 pH, are especially desirable where the soil is to be used for acid-loving plants, such as rhododendrons, azaleas, blueberries, gardenias, etc. However, application of these peats may be harmful to plants injured by acid conditions unless the soil has been previously well supplied with lime, or is given a lime treatment afterward, to counteract the acid effects of the humus material. Ordinarily, about 5 pounds of agricultural limestone per cubic yard of moist peat or per bale of dry moss peat may be considered a fair adjustment dosage. This may be mixed with the peat before spreading or may be separately applied to the soil, if both are to be worked in together. For especially acid-sensitive plants, twice these amounts may be used.

The less acid types of peat (at from 5.0 to 5.8 pH) are not sufficiently sour to make any material increase in the acidity of the soil to which they are applied; hence they are not suitable for use with acid-loving plants. Such materials usually contain a sufficient amount of calcium and magnesium to counteract any harmful effects to acid-sensitive plants, and it is not necessary to use lime with them, except as the soil upon which they are used may need correction of acidity.

Other effects on plant growth. The addition of peat to sand has been reliably reported to have a very beneficial effect upon the rooting of both hardwood and softwood cuttings that are difficult to root properly. This benefit is similar to that obtained from certain hormones and from Vitamin B_1 (thiamin). The hormone and vitamin contents of peaty materials have not been carefully studied, but it is quite possible that this may be the explanation of such plant growth response.

It is also known that some soils poor in organic matter, when treated with peat *and* favorable amounts of fertilizer, support a more vigorous plant growth than can be obtained from the fertilizer alone. The soil used in trials with various peats at this Station produced tobacco with broader and thicker leaves when treated with both peat and complete fertilizer than could be obtained with fertilizer alone. No consistent differences between peats were observed in this respect. This type of response is similar in nature to that reported for Vitamin B_1. However, soils of average fertility cannot be expected to show such improvement.

Suggested Uses of Peat and Swamp Humus

Potting soils. Peat is effectively used in connection with the potting of greenhouse plants. An inch or two of clear peat is placed in the bottom of the pot. The pot is filled with a mixture of peat and loam, in the proportion of three parts of loam to one part of peat. Unless the loam is noticeably sandy, it may be well to use two parts of loam, one part of sand and one part of peat. If the loam is especially poor in organic matter, or has not been composted with manure, a larger proportion of peat may be used. Good chemical fertility of the potting loam must be provided, either from manure or fertilizers.

Greenhouse plots. Most greenhouse plants are grown either in raised bench plots or in walled plots at or near the floor level. In either case, the soil is prepared to the depth of several inches. Unless the loam is well supplied with organic matter or heavily manured, the mixing of peat with the soil is a beneficial practice, following the same principles as indicated for potting soils. Strongly acid peats should be used if acid-loving plants are grown, as, for example, gardenias.

Coldframes. Peat is suitable for mixing with soils used in starting plants in coldframes. However, it has no heating effect, such as that obtained from the use of fresh manure in hotbeds.

Composts. Soils to be used for greenhouse planting, for top-dressing on turf and similar purposes, may be enriched with organic matter by composting with peat, manures, leaves and other organic residues. The use of one part of manure, two parts of peat and five or six parts of loam provides a suitable compost mixture for most purposes. The pile should be prepared some months in advance of use, and worked over repeatedly. The use of some manure along with the peat in the preparation of a compost soil favors its biological decomposition to a beneficial degree. If fresh leaves, grass residues, etc., are used to a considerable extent in the compost pile, some lime and fertilizer should be added. Suitable amounts are 5 pounds of limestone and 3 pounds of a 10-5-5, or a similar grade of fertilizer, per cubic yard.

Preparing soils for turf seeding. The best opportunity for improvement of soils for turf production is when the soil is worked up in preparation for seeding. If real benefit is to be expected from peat treatments, a liberal amount should be mixed into the soil at this time. Suitable rates are from 2 to 3 cubic yards of moist peat, or from 500 to 700 pounds of dry peat (3 to 4 bales of moss peat) per 1000 square feet, mixed with the soil to the depth of 3 or 4 inches.

Turf top-dressing. A single top-dressing of peat to grass turf has little effect, since only about one-half cubic yard or bale per 1000 square feet can be applied at one time without smothering the grass. The cumulative effects of several treatments may considerably improve the water absorption, moisture holding capacity and other physical conditions of unfavorable soils. However, if clear peat is used, the soil may gradually become too spongy. Hence it is probably a better practice to use a compost soil prepared from peat and loam for top-dressing purposes. Such treatments should supplement, rather than replace, turf fertilizer applications.

Mulching. Beds used for perennial flowers and shrubbery may be effectively mulched with peat for protection during the winter months and for improved moisture absorption. Rhododendron and similar acid-loving shrubs should be mulched with the more strongly acid types.

Flower beds and small vegetable gardens. Peat may be mixed with the soil in preparing for flower and vegetable planting in the same manner as for turf seeding. Large amounts, worked in to the depth of 8 inches or more, are preferable in such cases.

General agricultural uses. At current market prices for baled moss peat and other peat sold in competition with it, the cost per acre of sufficient quantities to be of significant benefit is beyond the limits of profitable returns. However, in many instances the farm includes some area of peat of suitable quality for soil improvement, and the only cost is that of digging and spreading. If this can be done for less than one dollar per cubic yard, such a local source of humus can be tapped to good advantage. It is unlikely that peat can fully replace animal manures, but it is reasonable to expect that much less manure would be required when used as a supplement to liberal dressings with local swamp peat. Labor saving machinery, such as small power excavators and tractors, may so reduce the cost of digging, hauling and spreading peat that the farmers of the future may again be able to use peat as profitably as was done two or three generations ago. The most promising fields for such agricultural uses of peat are for vegetable production and in the mulching of orchard trees.