17 THE USE OF PEAT AND PEAT SOILS FOR HORTICULTURE

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As has been shown in previous papers, a rather large part of the western part of the Netherlands was covered with peat. The part which consisted of moss peat, has been removed to a great extent by mans activities some centuries ago and used for fuel. With the invention of the dredging technique it became possible to remove all the peat, and deep lakes (4-6 m) with a clay bottom were left behind. Only small isles of peat remained between those lakes. Partly because they were occupied by settlements, but mostly because they did not consist of moss peat but of sedge or wood peat.

Now, most of the lakes have been drained and reclaimed. In these polders a rather large-scale agriculture has been developed. The reclamation was financed by merchants from the near-by towns, who earned their money in the oversea-trade. Therefore, most of the farmers in the polders did not originate from the peat region. The original inhabitants on the 'peat isles' only had small farms. To earn a living they were forced to very intensive exploitation: expensive crops, like vegetables, and several crops per year. A good market was at hand: the rapidly growing cities of Holland, whose inhabitants developed intensive industrial and trade activities. The industrial activities were originally partly based on the availibility of peat (De Zeeuw, 1978).

In this way a rather intensive horticulture was developed around Leiden, Haarlem and Amsterdam.

The horticultural development was also promoted by some favourable physical properties of the peat soils: workability, a high pore space with a high amount of easily available water and yet enough air (table 1).

A		B		C		D	
air %	moist.%	air %	moist.%	air %	moist.%	air %	moist.%
19	12	10	18	10	5	11	5

Table 1. Air content at pF 1.5 and easily available water (between pF 1.5 and 2.7) in a peat soil (A), a peat subsoil (B), a clay topsoil (C) and a clay subsoil (D). (According to Van der Knaap, 1976)

As a result these soils are very suitable for a rapid growth of vegetables like lettuce, cauliflower, celery. Under glass cucumbers and tomatoes give very high yields, but in spring, under low light-intensity, it is difficult to force plants into the generative stage (flowering). So one can not use these soils for earlies (e.g. tomatoes).

Most of these soils used for horticultural purposes, consist of a subsoil of sedge peat or wood peat, covered with a toplayer of decomposed ('earthified') peat mixed with clay or sand. This mineral enrichment is man-made. The clay was dug from the banks of old streams, which after the drainage of the peatland, by inversion became higher than the surroundings. The sand was dug from the dunes and shipped to the stables. This sandy manure was then mixed with mud dredged from the ditches and brought on the land.

The groundwater table must be kept high to prevent the peat from shrinking and oxidation (see Schothorst's paper). As a result of the high air content at low pF-values, roots can grow into proximity of the groundwater. A considerable amount of the necessary water-supply for the crops is therefore ensured by capillary rise. At the other hand, fluctuation of the groundwater level must be restricted between very narrow boundaries. To ensure both water supply and level control, a restricted distance between the ditches is necessary.

The growing demand for vegetables early and late in the season, lead the growers to the use of Dutch lights and afterwards to the building of heated glasshouses. Partly they switched over to the growth of flowers, especially around Aalsmeer, perhaps also stimulated by the short distance to the airport Schiphol. Today the horticultural area has extended from the peat uplands into the polders on the drained lake bottoms. The financial results made the growers economically stronger than the far-

mers, and at last the 'gardeners' outmatched the 'farmers'. As the parcelling in these polders is much better, the big modern 'flower-farms' are found on the loamy soils of the former bog floors.

During the last ten years the suitability of peat and loamy soils for growing roses, has been compared in the regio of Aalsmeer (Van der Knaap 1976, 1977; Van Rijssel, 1977, 1980). There is a very clear difference between these soils. The great amount of easily available water in the peat soils make high production possible if ..... there is enough light for assimilation. If not, the availability of water is disadvantageous for the number of flowers, flower quality and firmness of the stem. As a result there is on the mineral soils a bigger production at a higher price a piece in winter, whilst in summer the production on peat soils outmatches the mineral soils. It depends on the price-ratio in summer and winter whether the higher production in summer on peat soils can compensate the losses in winter, with respect to the mineral soils. Improving the quality in winter can be done by enlarging transpiration, which requires higher energy demands. With the increase of energy prices the disadvantage of peat soils will grow.

The need of stronger heating on peat soils is caused by a high heat conductivity, resulting in a higher value of the thermal diffusivity. This means a rapid decrease of temperature differences between top and bottom of a layer, or, with other words, great energy losses to the subsoil. Van Wijk (1969) calculated the course of soil temperature with depth and time in a mineral soil with a groundwater depth of about 100 cm, and a peat soil (moss-peat) with a groundwater depth of 40-50 cm, when in spring, after a period of winter-rest, roses are forced at a mean air temperature of 20°C (Figure 1).

Annex to this is the problem of sterilization of peat soils between two growing periods. Steaming may cause structural damage (shrinkage) and also takes a lot of energy because of the high heat capacity. Often a high manganese content is found in these organic soils, which becomes temporarily available after heating, and may then cause severe damage (e.g. in lettuce and roses). Now that the 'normal' chemical way by methylbromide (CH_3Br) is forbidden, this problem must be studied again.

The combination of a high organic matter content and a certain amount of clay causes a rather high cohesion of the topsoil, without the problems of bad workability that are inherent with heavy clay soils. Together

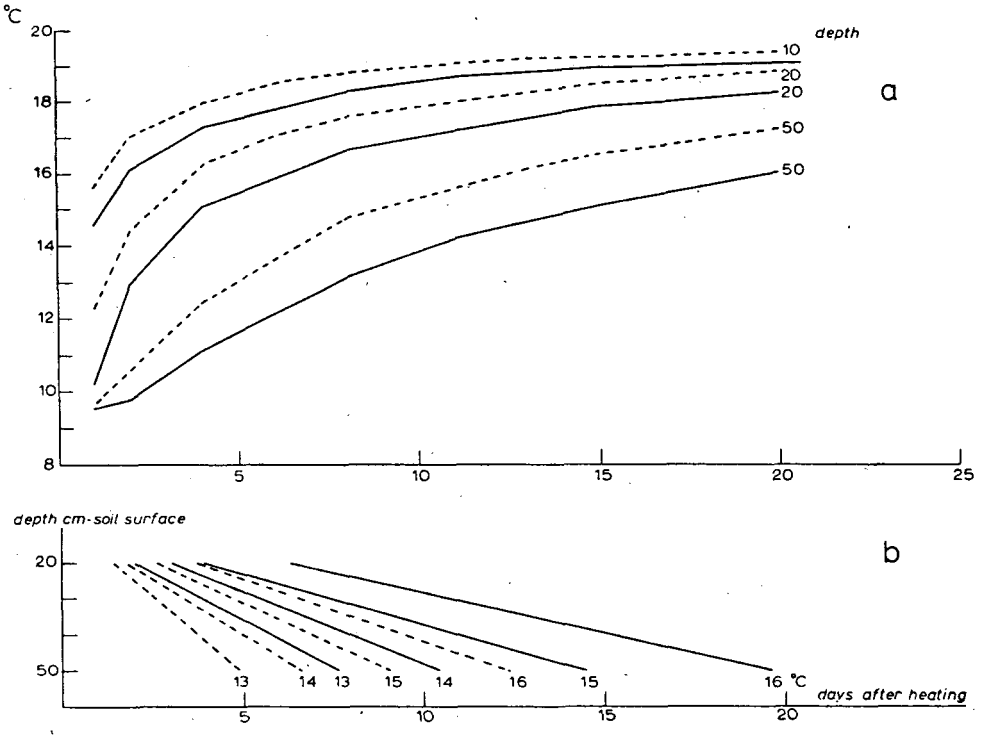

Fig.1. Comparison of the calculated course of soil temperature in the clay (--) and peat (—) soil at egual air temperature conditions; a. Course of soil temperature at 10, 20 and 50 cm below surface; b. Isotherms.

with a limited rooting depth as a result of the high groundwater level, very good root balls are formed. This property made these soils especially suited for the growth and forcing of Lilacs. These are grown for two years in the open air, brought into the glasshouse with the root ball, and after harvesting the flowers, planted again in the open air for the next two years.

These splendid root balls are also one of the fundaments of the nurseries around Boskoop. It enabled the growers to sell ornamental trees and shrubs with a high chance of success in regrowth. Around this village there is a concentration of rather small but very intensive nurseries, with a total area of about 900 ha. Already in the 15th century this activity is mentioned. The region belonged then to the rather rich monastery of Rijnsburg. Because of the bad quality of the peat for fuel, and

the absence of direct need of money, the peat was not dug, but the use for intensive nursery was promoted. It gave less money at the time, but lasted for centuries!

The subsoil, mostly wood peat, has a rather high water permeability, so water supply by subirrigation is possible. The high groundwater table (50-60 cm below surface) allows very little fluctuation, so the distance between ditches should be kept small. Originally, fields were 110 m wide (see Van der Linden's paper). For compensation of the loose of organic material by shrinkage and by the selling of root balls, sludge dredged from the ditches was used and often a ditch was dug in between. Fields then became about 52 m wide and sometimes even these were split up again into lots of 22-23 m wide. The transport for these very long and narrow strips was done by barges through the ditches. On the fields there was only a very narrow path, only wide enough for a wheelbarrow. Off-the-road transport was after all impossible because of the low bearing capacity of these soils. Planting was even done standing on planks, in order to protect the ideal soil structure.

After World War II a big improvement in the water management took place. A soil scientist (H.Egberts) strongly advocated subsurface drainage, consisting of a closed system of tiles ending in a pit with pump, consequently the water table can be controlled independently from the ditch level. Mechanization, especially for soil treatment, now became possible, because by a temporary lowering of the groundwater level the bearing capacity can be increased. These drainage systems also can be used for subirrigation when the land level is high enough (that is over 60 cm) above the water surface in the ditches. If the land lies lower, then subirrigation is impossible, because of a too high groundwater level. The capillary fringe never may reach into the regularly cultivated layer, that is 35-40 cm below surface. Nowadays a rather large part of this area has not enough height for this subirrigation, so sprinkling irrigation is often necessary.

As goes from Schothorst's paper, there are several causes for the sinking of the land level. In horticulture some of these factors are stronger than in grassland farming. The better drainage in wet times causes a certain settling of the subsoil. Another consequence of the better drainage system was the possibility of filling in the 'middle ditches'. After filling these ditches these strips are used as a transport road,

60% of the holdings now has a road of at least 2,5 m wide. This enforced the mechanization and as a result the need of deeper groundwater level. But the main cause of the sinking of the land level in horticulture however, is the removal of topsoil with root balls, and an insufficient replenishment with material from elsewhere.
Originally the nursery-men used mud from the ditches, but soon the demand was much larger than could be dredged. So, a 'soil trade' was born. Out of the lakes east of Aalsmeer, with the village of 'Vinkeveen' as a centre, thousands of tons of peat mud were dredged and shipped to Boskoop. Nowadays, dredging in the peat area around Vinkeveen is almost totally forbidden, because of environment-protection. The demand for completion material however is tremendous. A supply of about 75.000 m^3/y is estimated to be necessary only to compensate the normal losses, not to mention the backlog of the foregoing years (Aendekerk, 1979).
The completion material from Vinkeveen was a mixture of partly decomposed and fresh peat, with 60% organic matter, 40% mineral parts of which only 15% > 50 µm. Naturally there was a substantial loss of volume by shrinkage and oxydation in this fresh 'filling-soil', a loss that can be estimated between 25% and 35% by volume in the first and second year after filling. As a result, the remaining topsoil got slowly enriched in clay and more sticky. To improve workability and soil structure, a mixing of the topsoil with dunesand is now becoming quite a common soil improvement. The best results have been achieved with sand with a median around 200 µm. Dunesand fulfils this requirement, but has the disadvantage of a rather high pH. Normally these topsoils have a pH of 4.5 – 5.0 (pH-KCl), but after mixing with sand it may rise till 5.0 - 5.5. For some species that is rather high (e.g. Rhododendron).

Because this is a rahter wet growth, with a mean moisture tension of about pF 2.0, high demands are made upon the air content. 'Good' topsoils have a water retention curve like given in table 2.

pF $-\infty$	1,0	1,4	1,7	2,0
moisture % by volume	70	60	56	52	48

Table 2. Water retention curve of a 'Boskoop' topsoil

Nowadays, there is a frenetic search for substitutes. Among others one is making trials with mixtures of e.g. heather, grasses and sand. The problem is not yet solved.

At last, there is another way of using this peat material for horticultural purposes, namely as a very important component of soil-blocks. For the growth of seedlings of lettuce, tomatoes and cucumbers small blocks are pressed and seed is put on top. Blocks from pure moss peat are not enough coherent. But a mixture of half-decomposed moss peat, clay and mud from the Vinkeveen region was particularly suited. It was not only more 'sticky' than the moss peat, but also higher in pH (pH-KCl 5.0-5.5) and rather rich in trace elements. Millions of blocks have been pressed of the 'Vinkeveen' peat. But also for this purpose no more digging or dredging is allowed.

If we summarize, we can conclude that the peat soils of Western Holland have been very important for the birth of intensive horticulture. They offer very favourable growing conditions for the growth of vegetables and some flowers, but are not as well suited as mineral soils for earlies or winter-flowers. So, as a whole, for the growth of vegetables and flowers in heated glasshouses, mineral soils are preferable. The peat soils have great advantages for nurseries, especially when they grow ornamental trees and shrubs that are sold with root balls. As a result of this selling, and of shrinkage and oxydation, replenishment of topsoil is an urgent problem.

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18 REVIEW OF CHAPTER 17:
THE SIGNIFICANCE OF PEAT SOILS IN
NORTHWEST GERMANY FOR HORTICULTURE

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Peat soils are in Germany also very important for horticulture, special for the growth of rhododendrons, azaleas and conifers.
In the northwest of Germany we find in the district of Ostfriesland a large part of this country covered with peat. In earlier time the peat was used for fuel and for electric power, mainly in the small town 'Wiesmoor'. The steam from the power station heated glasshouses for production of vegetables. Now you will find in these glasshouses production of ornamental plants.
More important in this district is the growth of plants in the open land. The start of this nursery centre was the year 1928, when two nursery men started growing rhododendron and azaleas. Today here are 22 nurseries with a production of about 200 ha areal. The production is: rhododendrons in many sorts, so as hybrids and seedlings, azaleas for gardens and parks, conifers for gardens and cemetery plantation. 1,000,000 plants from calluna and ericas in several sorts are grown every year. So the district of Wiesmoor is important for the growth of nursery plants. The production is sold to other nurseries and garden centers in Germany. The production of this nurseries got an award of prices by many garden shows.
The nursery men learned horticulture in other nurseries, studied at an horticulture school and started with their own nursery. The earlier years were very heavy to raise plants, to sell them and to have money. After 5 to 10 years the production brings a turnover for living.
The production of nursery-plants in sorts as described brings many problems. At first the *knowledge* about the different plants, their propaga-

tion, their cultivation and also their selling. Young people have many to learn about these different plants.

Problems in the growth of these plants on peat ground. Plants start growing very late in spring, because the soil is cold and the warming is late in the year.

Fertilizing problems. The pH is 3.0-3.2 ($CaCl_2$), P_2O_5 here is no problem, but very important for the growth of conifers and the colour of these plants is K_2O, because peat has no sorbtion power for potassium[1], so every year potassium has to be applied. Microelements, like Fe, Cu, Mo and Mg cause many problems, special manuring with these fertilizers is necessary. Liming of peat soils is very important. The growth of roots and the growth of the plants is dependant on Ca.

The transplanting of rhododendrons and other plants is only possible in spring, so the nurseries have in this time much work. The nurseries have 1.5 workmen on 1 ha, that is compared with other types of horticulture and with agriculture very high.

To *use machines* for transplanting and digging out plants is not possible, because the peat is too soft for tractors and machines. All work is done by hand.

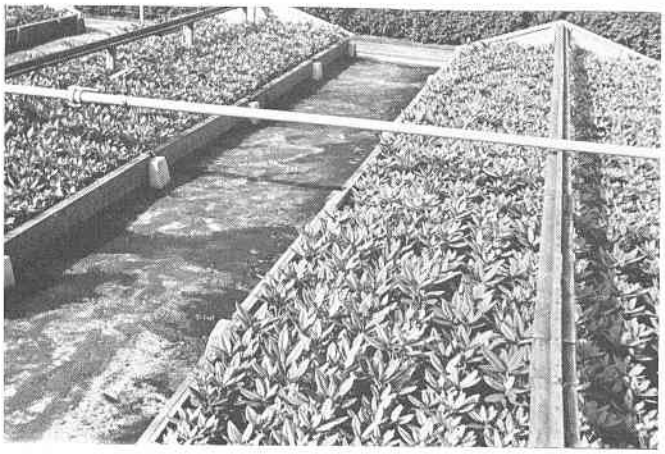
Another problem is *frost* in the month April, May and June. All nurseries have a sprinkler system for overhead-irrigation against the frost for protection of the plants.

Weed-control is on this peat soil a special problem, because the effect from different chemicals is not specified. Weed-control has to be done by hand.

The *maturing* from the different sorts needs 3-5 years, coming up from cutting and grafting, so rhododendrons needs 5-6 years before being marketable.

This kind of growing plants on peat soil is found especially in the northwest district of Germany and here you will find a special culture from rhododendrons, azaleas, erica and callunas and conifers in several sorts and arts and also here are many evergreen plants with a good result.

The production of conifers in several sorts and arts on peat soil in the distric northwest Germany, Wiesmoor
Photos Burchards



Propagation and growing-up of rhododendron-hybrids

Rhododendrons in the open ground

photos: Burchards

Note (from the editors)

1 This problem is unknown in the Boskoop area in The Netherlands with its clayey wood peat soils, although fertilizing with potassium is of course necessary. The difficulty must be caused by the ash-poor oligotrophic peat of Wiesmoor.