УДК 630*232.32

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HUMIDITY OF PEAT SUBSTRATE DURING GROWING OF INDOORS SEEDLINGS

The results of studies of moisture content and water holding capacity of the substrate in the cell cassettes "Plantek" 64F for the cultivation of container planting material. The moisture content of the substrate of cassette is taken at the output line of the Italian company "MosaGreenSrl" in RLSC, and then immersed in water for 48 hours is changed by the variants of experiment in the range of 19.1–48.0%. The absolute humidity for different versions is 414.9–539.6%. With the high amount of moisture in the substrate air is virtually absent, what adversely affects the growth of plants. Adding more moisture will be run-off from substrate with nutrient depletion. The relative humidity in this case is 80%. The results of determining the absolute and relative humidity of the substrate in the cell depending on the weight of the cassette are presented. The mass range was significant – from 2.9 to 7.4 kg for "Plantek" 64F and from 3.4 to 9.7 kg for "Plantek" 35F. To visualize and understand the relationship of humidity of the substrate and mass of the built cassette diagrams was build. They are revealed that the optimal mass range for the cassettes "Plantek" 35F is in the range of from 5.0 to 6.5 kg, brand "Plantek" 64F – 4.0–5.5 kg.

Key words: peat, absolute moisture, relative moisture, moisture content, cassette.

Introduction. Peat is a complex and multiphase polydisperse system. This is due to the heterogeneity of water in peat by its physical properties and interaction with dry peat substance.

Water in peat is divided into four categories: chemically bound, physically bound, osmotic and free [1].

Chemically bound water is retained in the peat most substantially and is not removed by heating the peat to 100–150°C. It is chemically bound to the peat by dry substance. Chemically bound water is contained in peat little.

Physically bound water – is oriented layers of water molecules at the interface with the particles of the solid peat phase. The layers of molecules that are directly adjoined with the surface of the particulate peat form a so-called adsorption water. This water is most strongly associated with peat and by physical properties differs from ordinary water. The specific weight of the adsorption water is 1.3–2.4. This water is not a solvent, such as sugar, which makes it easy to determine its amount in the peat. The physical properties of adsorption water approachit to the solids.

Adsorption water is contained in the damped peat and may also be in it due to the absorption of water vapor by peat from the air. The process of water vapor absorption by peat from the surrounding air is called the sorption and peat property itself to absorb moisture – hygroscopicity. Adsorption water cannot be removed from the peat by squeezing.

The layers of water more removed from the surface of solid particles are less oriented. As the distance from the solid phase boundaries increases, their density decreases and reaches normal values.

These layers of water form the so-called light bound or diffusion water. Diffusion layers can easily be destroyed by heat.

Physically bound water in peat is 20–30% per a dry substance. With this water content, its layer is equal to 50 molecular diameters. The raw peat was stated to have more bound water than dry peat. When peat humidity is 40–50% all enclosed in it water is in a bound state.

Osmotic water is contained in the cells of the remained plants residues. The walls of plant cells can absorb moisture or release it during peat drying or by mechanical destruction of cells. Osmo-tic water is also considered to be retained by ion layers.

One of the types of free water of peat is that one which is in microcapillaries. This water is considered to be a part of the hygroscopic water. Its content in the peat is 25–30% per a dry matter. It can be removed from peat at high pressures only.

The second type of free water is capillary water contained in the pores. This type of water prevails in peat. It is the most mobile and can be removed from the peat by squeezing. Also in the pores, there is gravitational water. This water is weakly bound to the solid peat body and can be removed from it by filtration under its own weight.

Peat is a hydrophilic material. However, if on the surface of dry peat (powder) there is a layer of adsorbed air, it is poorly wetted, and by mechanical mixing only, when air shell is destroyed, wetting is enhanced.

Main part. To fill the cassettes in "MosaGreenSrl" Italian firm line of NFBSPC the substrate prepared in RPU "Dokshitsyraygaz" was used. For preparing the substrate they took the cotton grass-sphagnum peat of milling processing, the degree of decomposition of harvested peat – 18%, ash content – 12.9%.

To study the humidity and the water capacity of the substrate in the "Plantek" cassette cells 64F,

taken at the seeding line output of Italian firm "MosaGreenSrl", and then submerged in water for 48 hours, all the cells with the substrate were selected diagonally (one diagonal tape contains 8 cells) (Table).

Determination results of moisture and moisture capacity of the substrate in "Plantek" cells cassette 64F

Numbers of cells	Dry weight humidity (absolute humidity), %	Humidity on a damped sample (relative humidity), %	Humidity of substrate in cassette cells at output line from seedling line, %
1	539.6	84.4	48.0
2	414.9	80.6	19.1
3	460.9	82.2	29.7
4	463.8	82.3	30.4
5	462.5	82.2	30.1
6	426.0	81.0	21.7
7	454.3	82.0	28.2
8	457.3	82.1	28.9
9	443.1	81.6	25.6
10	438.8	81.4	24.6
11	454.5	82.0	28.3
12	455.3	82.0	28.5
13	445.9	81.7	26.3
14	452.4	81.9	27.8
15	443.2	81.6	25.7
16	436.9	81.4	24.2

Experience shows that the moisture content of the cassette substrate taken at the output from the Italian firm "MosaGreenSrl" NFBSPC line, and then submerged in water for 48 hours, varies according to the options of experience within the 19.1–48.0%. This is an amount of water that after addition of it to the substrate it is able to hold. Having such an amount of moisture there is no practically air in the substrate that negatively affects the growth of plants. When adding a larger amount of moisture the elution of nutrients from the substrate occurs.

Absolute humidity in the variants of experiment is equal to 414.9–539.6%. Based on these data the dry substance of the substrate can be seen to retain moisture in 4–5 times more than its weight.

Thus, one can argue that if the absolute humidity of the substrate is more than 400% there is no practically air in it, and it is impossible for the successful development of plants. The relative humidity in this case ranges at 80%.

Because of humidification of substrate taken from baled Big Bohl, duringstuffing the cassettes, absolute humidity increases by 4.2 times. With absolute humidity of the substrate about 332%, the cassettes come into the ground.

Weighting of cassettes in NFBSPC was held selectively by 20 pieces.

The weight of empty "Plantek" 64F cassettes was 0.94–0.96 kg, with peat after stuffing the cassettes was 3.78–3.96 kg, at the output of the Italian firm "MosaGreenSrl" line after humidification was 4.46–4.80 kg.

The weight of empty "Plantek" 35F cassettes was 1.10–1.11 kg, the weight of these cassettes at the output of the Italian firm "MosaGreenSrl" line after humidification – 4.82–5.66 kg. The weight of cassette with substrate without watering was 4.4 kg, corresponds to absolute humidity 135.6%.

In NFBSPC and some forestry enterprises in the conditions of indoor ground during the growing season in 2015 the selection of the substrate samples was made from the cassettes to study the effect of irrigation intensity on the substrate humidification.

To determine the substrate humidity the sampling selection was carried out from suspended cassettes taken in various parts of the greenhouses. The mass range during weighting was significant – from 2.9 to 7.3 kg for the "Plantek" 64F cassettes and from 3.4 to 9.7 kg for the "Plantek" 35F.

The cassettes in NFBSPC differed by the smallest weights, but there was a slight surplus-standard of cassettes watering [2] in the new greenhouse where Scots pine seedlings were grown. Watering system was not fully adjusted. Mass of the cassettes was as far as 6.5 kg, the absolute humidity approaching 400%, corresponding to almost complete moisture saturation of the substrate with water.

In NFBSPC in June when growing pine on indoor ground the difference between the maximum and minimum value of the absolute humidity of the selected substrate samples from the cassettes was 52.8% (1.3 times), in July, during the growth of Scots pine – 166.5% (1.8 times), in July, during the growth of Norway spruce – 127.1% (1.7 times). In SEFI "Gluboksky experimental forestry enterprise" in June when growing spruce difference was 76.0% (1.2 times); in SFI "Ivie Forestry" in June when growing spruce – 130.4% (1.5 times), and in July – 309.8% (4.3 times); in SFI "Novogrudok Forestry" in July, during the growth of Norway spruce – 322.8% (2.6 times); in SFI "Minsk Forestry" in July, during the growth of Scots pine – 236.5% (2.6 times).

The relationship between the mass of the cassettes and the absolute and relative humidity is shown in Fig. 1–4.

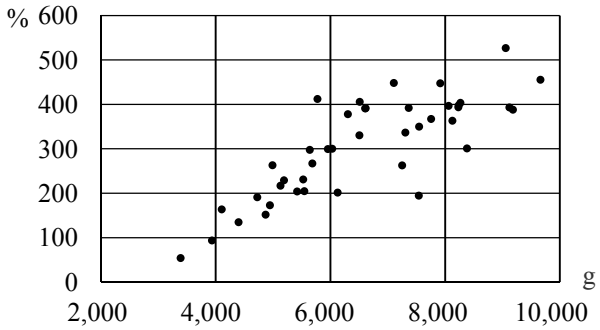

Fig. 1. The relationship between mass of the cassettes and the absolute humidity for "Plantek" 35F cassettes

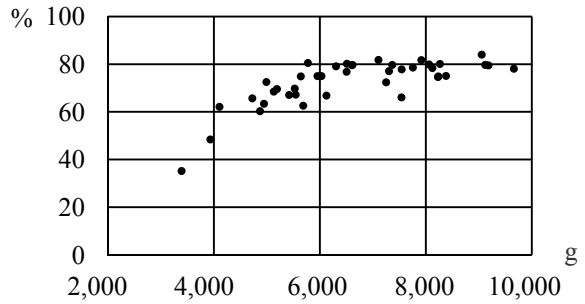

Fig. 2. The relationship between mass of cassettes and relative humidity for "Plantek" 35F cassettes

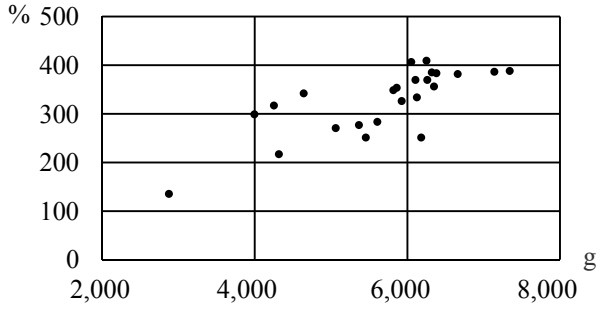

Fig. 3. The relationship between mass of cassettes and absolute humidity for "Plantek" 64F cassettes

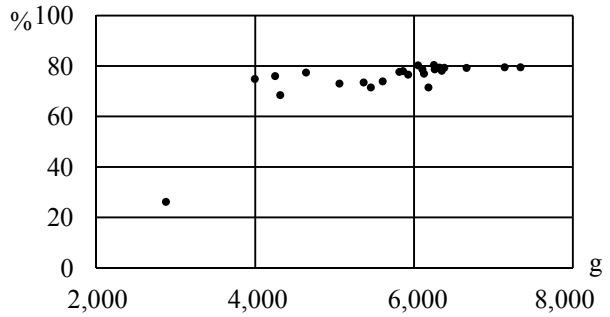

Fig. 4. The relationship between mass of cassettes and relative humidity for "Plantek" 64F cassettes

The full moisture saturation of peat occurs when absolute humidity is 400–450%, respectively, the critical threshold of this parameter can be humidity of 300–350%. The minimum limit of absolute humidity is 200%. The range of optimum weights for "Plantek" 35F cassettes should be in the range from 5.0 to 6.5 kg.

For "Plantek" 64F cassettes such a clear dependence has not been received because of the fact that this type of cassettes has a small volume of the container, thus resulting to a great differentiation of humidity even within a single cassette. Therefore, the selection of a single cell of the cassette gives a big experimental error. However, in vitro mass of the cassette fully saturated with water, which is 5.8 kg, was determined. Hence, the optimal range of the cassettes masses will be 4.0–5.5 kg.

Conclusion. The studies revealed that the total moisture content of the substrate occurs when the absolute humidity is 414.9–539.6%. The absolute humidity of the substrate in cassettes immediately after seeding is within 330%. To maintain optimum water-air balance it is necessary to have the absolute humidity of the substrate 200–350%. Such humidity indexes are achieved in the range from 5.0 to 6.5 kg for "Plantek" cassettes 35F mass, and for "Plantek" 64F cassettes this value is 4.0–5.5 kg.

References

1. Kostyuk N. S. *Fizika torfa* [Physics of peat]. Minsk, Vysheyshaya shkola Publ., 1967. 216 p.

2. Yakimov N. I. Agrotechnics of cultivation of forest container planting material. *Trudy BGTU* [Proceedings of BSTU], series I, Forestry, 2006, issue XIV, pp. 204–206 (In Russian).

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Received 16.02.2016