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FEATURES OF WATER REGIME OF THE MAIN SOIL TYPES IN KINBURN SAND ARENA

Hard natural and hydro-edaphic factors are restricted range of forest species in region and only two species – Scotch pine and Crimean pine can tolerate the extreme of environmental conditions. Soil water regime does not depend only on rainfall quantity but also on the water properties of the soil which include water capacity, permeability, water lifting capacity, evaporation and water absorption capacity. Soil and forest typology descriptions have made at the rate of 1/300 ha. Sixty soil-forest typology descriptions of Kinburn sand arena have been processed. It's identified and described in detail the five main soil types, the most common of which are sandy sod developed in ancient alluvial deposits of sand and sod-gley underdeveloped buried in black soil. The samples for water regime research include the amount of 30 pieces in different types of soil, different age in Crimean and Scotch pine plantations in rows and spaces between rows. Permeability measurements were performed in a 10-fold repetition using a steel cylinder height of 10 cm. Cylinder put in the soil in half and filled the rest with water to 50 mm graduations, corresponding indicator showers and measure off full soil water absorption. It's found out that field soil moisture was varying between 4-30 % by weight of absolutely dry soil. The lowest value of water capacity was recorded in sod-developed sandy soils on ancient alluvial sand deposits, which amounted to 4.2 %. The intensity of the absorption of water in different hydrology sites was distributed in the following order (highest): very dry pine forests – dry pine forests – fresh pine forests. Compacting soil in rows affected the rate of water penetration, which in 1.2-1.5 times increased the rate of water seepage between rows compared to the series. The results of hydrological studies show that soils of Kinburn sand arena are relating to the sweat type of water regime where moisture, which is losing ground significantly exceeds precipitation.

Keywords: genetic soil horizon; water capacity; permeability; water lifting capacity; evaporation; water absorption.

Introduction. Current "Ukrainian Sahara" – Downdnieper or Oleshkivski Sands is located in the steppe zone of Ukraine and occupied about 210 th. ha stretching along the left bank of Dnieper from Kakhovka to the coast of the Black Sea in Kherson and Mykolaiv regions.

Hard natural and hydro-edaphic factors (oligotroph sites of sand, the large capacity of salts in the soil, frequent droughts and minimum annual rainfall) are restricted range of forest species, since almost all plantations are created as monocultures of Scotch pine (*Pinus sylvestris* L.) or Crimean pine (*Pinus pallasiana* Lamb.), the species that can tolerate the extreme environmental conditions of the region (Vinogradov, 1973; Gordienko, et al., 2002, Siryk, 1991; Shevchuk, et al., 2005; Shevchuk, 2002).

Soil water regime does not depend only on rainfall quantity but also on the water properties of the soil. Water properties of the soil include water capacity, permeability, water lifting capacity, evaporation and water absorption capacity (Kupchyk, et al., 2007; Gnatenko, et al., 2005).

Water capacity is the ability of soil to absorb and retain some moisture (Gnatenko, et al., 2005; Tymoshenko, 1975). It is expressed as a percentage of the mass of soil, while keeping the bulk density (in mm for a layer of soil). Water capacity typically increases as the number of clay particles in the soil. It is known that the field moisture for sands is 4-9 %, sandy soils – 10-17, slight and medium sandy loams – 18-30 and heavy clay soils – 23-40 % by weight of absolutely dry soil. The organogenic horizons contain the most quantity of moisture. The duff and peat hold moisture in 5-20 times more than its own weight (Agaponov, 2001; Vedmid & Raspopina, 2010).

Permeability is the ability of soil to absorb and hold water from the upper into the lower horizons. The process divides into uptake and filtration. Uptake is manifested by incomplete saturation of soil moisture, i.e. when the pores is not completely filled with water, and also include the sorption and capillary forces. Filtering occurs at the maximum saturation of soil moisture. Permeability measures by the height of the water column, which leaked into the soil over time, and this is called the coefficient of filtration. Permeability depends on the texture, content of humus substances and soil structure. Water is the better seeping in sandy soils than in clay soils. Permeability of soil structural is greater than unstructured. The first study of water filtration in the soil was carried out on the sands of the French scientist Darcy in 1854 (Gnatenko, et al., 2005).

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Water lifting capacity (capillary) is the ability of the soil slowly absorbs the water on the capillary gaps under tension of water forces that is the interaction of water with soil particles. The height and speed of the capillary lifting water depends on the diameter of capillaries, the thinner they are, the higher the elevation, and vice versa (Gladun, Trophymenko & Lokhmatov, 2005; Gordienko, et al., 2002).

Part of the water that enters the soil evaporates. Evaporation rate depends on the mechanical and structural composition of the soil. Clay and loamy soils with a high capillarity evaporate more water than light soils such as sand. Structural soil in compare with not structural lose less moisture. The vegetation reduces evaporation (Druchenko, 1939; Siryk, 1991).

Water absorption is the ability of soil to absorb water vapor from the air. Water absorption depends on the texture of the soil and humus content. The more clay particles in the soil and humus, the more are water absorption.

The aim of study was to identify the main variety of soil types, setting power of genetic horizons, features of water regime of the main types of soils in Kinburn sand arena.

Material and methods of research. The study of forest sites in Kinburn sand arena was conducted in July and August 2015 during soil and forest typology expedition of Industrial Association "Ukrainian state forest project". Soil and forest typology descriptions have made at the rate of 1/300 ha (Krut & Tymoshenko, 2014). Whereas the Kinburn peninsula area is 17890.2 hectares where 60 edaphic descriptions were studied and worked out.

The samples for permeability include the amount of 30 pieces in different types of soil and established on September 2016. Soil permeability was investigated in different age in pine plantations in rows and spaces between rows within Kinburnsky and Vasilevsky Forestry's belonging to State Enterprise "Ochakivski Forest Hunting Range". Permeability measurements were performed in a 10-fold repetition.

These types of soils as swamp loam on ancient alluvial sandy sediments, humus-bog sandy on ancient alluvial sand deposits and saltwort average loam sandy occur locally on the territory of Kinburn peninsula, but for the complete description of permeability soils in Kinburn sand arena was also taken plots in 3-fold repetition in the olive, black alder and black Locust plantations (Kupchyk, et al., 2007; Gnatenko, et al., 2005; Druchenko, 1939).

Soil permeability was measured using a steel cylinder height of 10 cm (Ivanina, 1975; Tymoshenko, 1975). Cylinder put in the soil in half and filled the rest with water to 50 mm graduations, corresponding indicator showers and measure off full soil water absorption.

Results and discussion. Soil and forest typology descriptions were processed during office work and for analysis the descriptions was highlighted five main types of soil: marsh sandy on ancient alluvial sand deposits (A), humus-bog sandy on ancient alluvial sand deposits (B), saltwort average loam (C), sod developed in ancient alluvial sandy sediments (D) and underdeveloped sod-gley buried in the black soil ancient alluvial deposits (E). The power of genetic horizons of the main soil types is shown in Fig. 1.

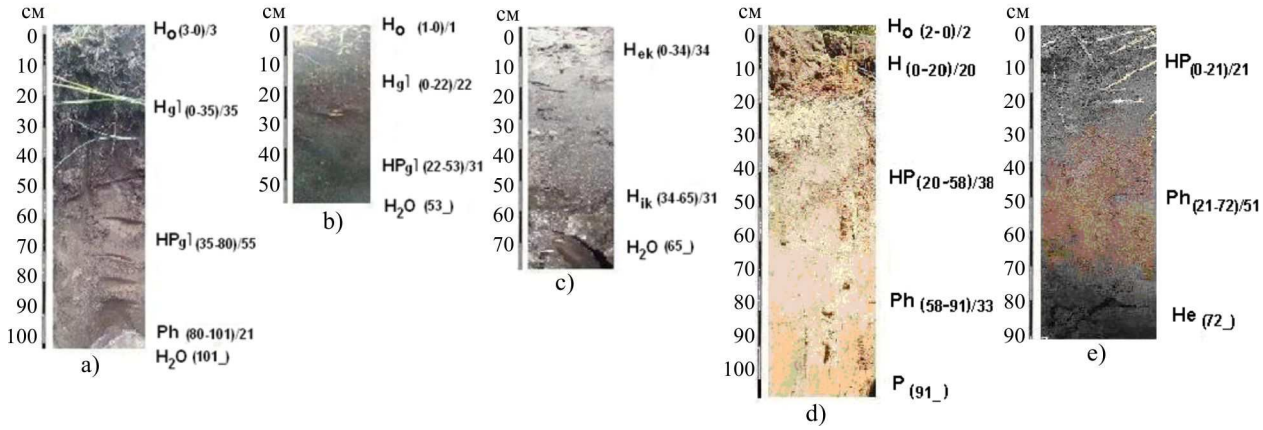

Fig. 1. Basic types of soils in Kinburn sand arena: A – sandy marsh on ancient alluvial sand deposits; B – humus-sandy marsh on ancient alluvial sand deposits; C – saltwort average loam; D – sod developed in ancient alluvial sand deposits; E – underdeveloped sod-gley buried in the black soil ancient alluvial deposits

Profile of sod-gley soil underdeveloped debt at ancient alluvial deposits buried in the black soil reached power of 135 cm depth. On humus-bog sandy soil minimum power was 51 cm and below this level were groundwater. Texture of soil horizons of all types of soils represents sand of different fractions with a small proportion of clay. The structure of the upper horizons is Micro structural, lower – granular. Soil density increases from the upper to the lower horizons, which is consistent with the data of different authors (Vinogradov, 1973; Krut & Tymoshenko, 2014).

Neoplasm represented in all types of soil in the form of soluble salts. Inclusion in the upper horizons can be traced as the roots of various plants, except humus-marsh and swamp-loam soils which include common across all layers of the entire genetic profile. Agronomic characteristics of the soil is low, very little nutrients, the presence of soluble salts complicates the natural absorption and aeration of the soil (Agaponov, 2001; Gordienko, et al., 2002; Siryk, 1991). To maintain forestry and agricultural practices, soils require additional agronomic and reclamation activities.

Research of field capacity showed that its value ranging 4-30 % by mass of absolutely dry soil. The lowest value of this indicator was recorded in sod-developed sandy soils on ancient alluvial sand deposits, which amounted to 4.2 %. Averaged data of permeability depending on the type of soil and vegetation structure are shown in the Table.

Analysis of the table data indicates that the species composition of pine plantations do not significantly affect the intensity and time of water absorption by soil. Instead it's seen the intensity of water absorption by soil of stand age, type of site conditions and the type of soil.

Table – Indicators of soil permeability of Kinburn sand arena

Number of sample	Type of site	Composition	Age, years	Soil type	Time of absorption, min	Intensity of absorption, mm·min^{-1}	Time of absorption, min	Intensity of absorption, mm·min^{-1}
					in rows		between rows	
1	A_0	10 Pine Crimean	53	D	18,4	2,72	17,5	2,86
2	A_0	10 Pine	34	D	16,5	3,02	15,2	3,29
3	A_0	10 Pine Crimean	12	E	20,0	2,50	15,1	3,31
4	A_1	10 Pine Crimean	42	D	26,4	1,89	24	2,08
5	A_1	10 Pine Crimean	24	D	26,2	1,91	22	2,27
6	A_1	10 Pine Crimean	6	D	25,5	1,96	19,6	2,56
7	A_2	10 Pine	49	E	48,0	1,04	40,0	1,25
8	A_2	10 Pine	33	D	44,6	1,12	41,2	1,22
9	A_2	10 Pine Crimean	9	D	42,3	1,18	38,4	1,30
10	B_1	6Acacia 3Maple 1Alder	40	A	49,0	1,02	45,5	1,12
11	B_3	10 Black Alder	60	B	52,4	0,95	50,1	1,03
12	A_2H_1	10 Olive	20	C	43,5	1,15	42,1	1,19

To set the intensity of the mathematical water absorption on the type of forest site quality indicators background A_0, A_1, A_2, B_1, B_3 and A_2H_1 were transformed into quantitative values that become 10, 20, 30, 40, 50 and 60 respectively. The relationship between the intensity of the absorption water and forest type of site express by polynomial functions with high degree of approximation. The functional dependence of water absorption according to the rows and between rows of different sites is described by formulas 1 and 2.

$$y = 0,0015x^2 - 0,1329x + 3,9101;\ R^2 = 0,942, \quad (1)$$

$$y = 0,0017x^2 - 0,1569x + 4,6324;\ R^2 = 0,952\ . \quad (2)$$

Graphic interpretation of the dependencies is shown in Fig. 2. Data of Fig. 2 shows more intense manifestation of permeability between the rows, and very noticeable in the poor forest site. For example, in a dry pine forest intensity of permeability reaches a maximum between rows 3.31 mm·min^{-1} and in row 3.02 mm·min^{-1}, while in the fresh pine forest these figures are – 1.30 and 1.18 mm·min^{-1} correspondingly. In the wet pine forests soil absorption intensity throughout the area of supply of seedlings is almost identical 0,95-1,0 mm·min^{-1}. The intensity of the absorption in transition forest site A_2H_1 depends on the area of supply and reduces to 1.15 mm·min^{-1}.

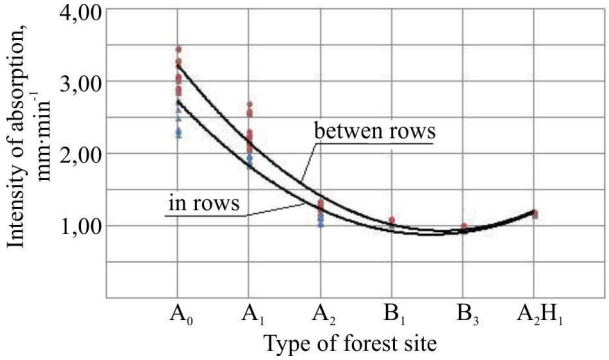

Fig. 2. The intensity of the absorption of rain depending on forest site

The intensity of the water absorption in different hydrotops is distributed in sequence in descending order: very dry pine forests – dry pine forests – fresh pine forests. At all plots water in 1.21.5 times faster impregnates into the soil between rows in comparison with the rows.

Results of permeability soils show that all soil differences relates to the medium permeable soils as the water for the first hour is held from 5 to 15 cm. This is explained the lowest structure of sandy soil and the consequent rapid seepage of water into the soil and wicking.

Water lifting capacity of soil is characterized by high speed and height of elevation. The highest height of water elevation is marked on 0.5 meters in saline soils medium sandy loam and sod-gley underdeveloped buried in the black soil. In sod-loamy soils developed in ancient alluvial sand deposits the rate of water elevation was higher, but raising the height of water reaches only 10 cm of height.

The ability of evaporation is least at sod-developed ancient alluvial loam to sandy sediments. Evaporation from the soil is increased on saline soils medium humus-sandy marsh on ancient alluvial sand deposits.

The value of soil water absorption is not constant. It is affected by temperature and humidity. The higher the humidity the more is water absorption. At full saturation of air with water vapor the upper limit of water absorption reaches and it is called maximum of water absorption. Research hygroscopic most popular sandy soils of Kinburn sand arena showed that the smallest size (0,53,3 %), it reaches a sandy turf-developed in ancient alluvial sand deposits and the largest – in saline soils medium sand loam (5,46,1 %).

Thus, the results of hydrological studies argue that soils of Kinburn sand arena relate to perspire type of water regime where moisture, which is losing by ground significantly exceeds the precipitation.

Conclusions. According to research of 60 soil and forest typology descriptions for Kinburn sand arena 5 major soil types are identified, the most common of which are sandy sod developed in ancient alluvial deposits of sand and sod-gley underdeveloped buried in the black soil ancient alluvial deposits.

Established, that the field water capacity of soil varies between 4-30 % by weight of absolutely dry soil. The lowest value of this indicator was recorded in sod-developed sandy soils on ancient alluvial sand deposits, which amounted to 4.2 %. Composition of species of pine plantations is not significantly affect the intensity and time of water absorption by ground.

The relationship between the intensity of the absorption water and forest type of site express by polynomial functions with high degree of approximation. Water in the rows quickly penetrates the soil than between rows and it is very noticeable in the poor site conditions. The intensity of the water absorption in different hydrotops distributes in descending order as follows: very dry pine forests – dry pine forests – fresh pine forests. All plots in rows water in 1.21.5 times faster impregnated into the soil compared to the spaces between rows.

Research of soil hygroscopic is showed that the smallest value (0,53,3 %) it reaches a sandy turf-developed ancient alluvial sand deposits, and the largest – in saline soils medium loam sand (5,46,1 %). In terms of hydrological studies sandy soils of Kinburn sand arena relate to perspire type of water regime.

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ОСОБЛИВОСТІ ВОДНОГО РЕЖИМУ ОСНОВНИХ ТИПІВ ҐРУНТІВ КІНБУРНСЬКОЇ ПІЩАНОЇ АРЕНИ

Опрацьовано 60 ґрунтово-лісотипологічних описів Кінбурнської піщаної арени. Виявлено і детально охарактеризовано п'ять основних типів ґрунтів, найпоширенішими з яких є дерновий розвинений супіщаний на давньоалювіальних піщаних відкладеннях та дерново-слаборозвинений глейовий на похованих чорноземних ґрунтах. Встановлено, що польова вологовміст ґрунтів змінюється в межах 4-30 % від ваги абсолютно сухого ґрунту. Найменше значення цього показника зафіксовано у дерново-розвинених супіщаних ґрунтах на давньоалювіальних піщаних відкладеннях, яке становило 4,2 %. Інтенсивність поглинання води в різних гігротопах розподілилася у такій послідовності (за зменшенням): дуже сухі бори – сухі бори – свіжі бори. Ущільнення ґрунту в рядах вплинуло на швидкість водопроникності, яка у 1,2-1,5 раза перевищувала показник просочування води у міжряддях порівняно з рядами. Результати гідрологічних досліджень показали, що ґрунти Кінбурнської піщаної арени належать до випітного типу водного режиму, де кількість вологи, яку втрачає ґрунт, значно перевищує кількість опадів.

Ключові слова: генетичні горизонти; вологовміст; водопроникність; водопіднімальна здатність; випаровуваність; гігроскопічність.

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ОСОБЕННОСТИ ВОДНОГО РЕЖИМА ОСНОВНЫХ ТИПОВ ПОЧВ КИНБУРНСКОЙ ПЕСЧАНОЙ АРЕНЫ

Обработаны 60 почвенно-лесотипологических описаний Кинбурнской песчаной арены. Выявлено и подробно описано 5 основных типов почв, наиболее распространенными из которых являются дерновый развитый супесчаный на древних песчаных отложениях и дерновый слаборазвитый глеевой на погребенных черноземных почвах. Установлено, что полевая влажность почвы колеблется в пределах 4-30 % от массы абсолютно сухой почвы. Наименьшее значение данного показателя зафиксировано в дерново-развитых песчаных почвах на древнеаллювиальных песчаных отложениях, которое составило 4,2 %. Интенсивность поглощения воды в разных гигротопах распределена в следующем порядке (по убыванию): очень сухие боры – сухие боры – свежие боры. Уплотнение почвы в рядах повлияло на скорость проникновения воды, которая в 1,2-1,5 раза превышала показатель просачивания воды между рядами по сравнению с аналогичными показателями в рядах. Результаты гидрологических исследований показали, что почвы Кинбурнской песчаной арены относятся к выпотному типу водного режима, где количество влаги, которую теряет почва, значительно превышает количество осадков.

Ключевые слова: генетические горизонты; влагоемкость; водопроницаемость; водоподъемная способность; испарение; гигроскопичность.

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