REGULARITIES OF DESICCATION BY NEEDLE SAMPLES COLLECTED FROM RAMULES OF FIR-TREES, GROWING ON TERRITORY OF FOREST ECOSYSTEM

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The trees as higher plants in any age are capable to accumulate annually a state information of territory, on which they vegetate. Therefore tree, in particular fir-tree, is a very good indicator, recording an ecological situation [1]. However now fir-tree needle properties are insufficiently investigated, and also the parameters of an ecological state and criterions of fir-tree needle evaluation are not determined, with the help of which it is possible adequately to carry out ecological monitoring of a fir-tree habitat.

The purpose of the article - to show regularities of desiccation by weight by needle samples collected from fir-trees growing in conditions of forest ecosystem.

For consummation of the purpose in view the following problems were decided:

1) the samples of needles of a fir-trees growing in forest conditions were selected;

2) fir-tree needle desiccation dynamics parameter variance regularities, such as an initial mass of a moisture in samples and the first passage time of a constant air - dry mass of needle samples were determined by the method of statistical modelling;

3) the mean deliquification rate for all needle samples was designed.

For realization of experiment four small fir-trees *Picea abies*, growing on territory of scientific-experimental forestry enterprise of Mari state technical university (46 compartment, 1 subcompartment) were selected. The distance from auto-road was more than 50 m. Besides the fir-trees were selected so that they were from each other approximately on a distance 10 m along across-the-grain section in proportion to increase of distance from a road.

Then verticil was selected on each accountable fir-tree, after selected a limb inside selected verticil with a measurement of a geodesic its stem direction. Then basic sample as ramule for the analysis its water retention ability was snipped from a stem extremity. After snipping each ramule was put into a container for transportation, and then on cut ramules in laboratory conditions needles were separated from a stem. In the following in room conditions needle sample was many times weighed with drying before constant mass obtainment.

On accountable fir-tree limbs from which ramule samples have been cut, were selected in four light directions.

Ramules as samples for the analysis their water retention ability were cut from limbs from stem extremity approximately at height 1,3 m from a ground-level.

Containers for transportation of each sample from a snipping place to laboratory were produced as paper packets. On each packet sample snipping time, cardinal direction, and also accountable fir-tree number were marked. Weighed needle samples were kept in room conditions in other containers executed as open boxes, on which also accountable tree number and cardinal direction were noted.

During sample selection for realization of the water retention ability analysis on an accountable fir-tree from each cardinal direction only ramule was cut, and also snipping was conducted after vegetation period, in the beginning of January, 2009 and for the analysis ramules were taken only with annotinous needles.

In table 1 the significances of needle sample mass for an accountable fir-tree № 2 are represented.

Table 1. Desiccation dynamics by needle samples of a fir-tree № 2

Interval, days	Needle sample mass, g			
	North	South	East	West
0,028	0,430	0,431	0,687	0,580
0,077	0,410	0,409	0,661	0,559
0,119	0,399	0,395	0,643	0,546
0,161	0,389	0,388	0,629	0,536
0,203	0,382	0,377	0,617	0,527
0,245	0,374	0,368	0,605	0,519
0,350	0,354	0,349	0,580	0,498
0,475	0,339	0,334	0,553	0,479
0,933	0,289	0,283	0,472	0,410
1,058	0,277	0,271	0,455	0,397
1,100	0,275	0,269	0,446	0,390
1,225	0,267	0,259	0,435	0,382
1,392	0,255	0,249	0,416	0,366
1,517	0,251	0,244	0,406	0,357
1,85	0,238	0,230	0,380	0,336
2,142	0,227	0,220	0,367	0,320
2,392	0,221	0,211	0,353	0,309
2,934	0,211	0,202	0,335	0,290
3,476	0,205	0,194	0,323	0,280
3,789	0,205	0,195	0,319	0,274
4,226	0,204	0,193	0,314	0,272
6,039	0,195	0,190	0,300	0,256
7,976	0,193	0,189	0,296	0,253
9,976	0,190	0,187	0,293	0,251
12,455	0,191	0,191	0,296	0,253
19,392	0,192	0,190	0,295	0,251
28,017	0,193	0,192	0,297	0,253

In room conditions study of dynamics of desiccation contained in samples on needle sample mass measurements was conducted. Besides at first six hours after snipping the weighing was conducted in each hour, then through each three hours, and on second and per consequent day of week - also through each three hours. Then some days of samples were weighed two - three times in daylight, and further during several days - once in day, after once in some days and in an extremity - once per one week. Besides the measurements were conducted, while their mass didn't achieve constant significance for mass oscillation within weighing error.

The fir-tree needle sample mass measurement data were subjected to statistical processing [2, 3] in a software envelope Curve Expert 1.3.

By dint of statistical modelling model of dynamics of desiccation by needle sample, for example collected from a fir-tree № 2 from northern cardinal direction have revealed as the formula:

$$m = m_{m0}\exp(-a_1 t^{a_2}) + m_d = 0{,}247497\exp(-1{,}011468t^{0{,}838073}) + 0{,}19196, \quad (1)$$

where m - dynamic mass of sample during of air drying process, g; m_{m0} - initial mass of a moisture in sample, g; $m_{m0}\exp(-a_1 t^{a_2})$ - variable mass of lost moisture by sample changed on the death distribution, g; m_d - constant the mass of air - dry needles including their hygroscopic moisture and their dry wood pulp, g; t - air drying time from the moment of sample snipping, days.

In a fig. 1 the graph of desiccation by needle sample collected from an accountable fir-tree № 2 from northern cardinal direction is represented.

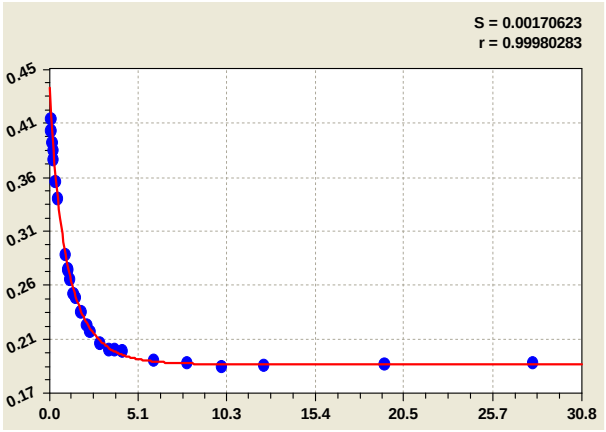

Fig. 1. The graph of desiccation by needle sample collected from cut ramule of fir-tree № 2 from northern cardinal direction

As it is visible in a fig. 1, the process of desiccation by fir-tree needles flows on the exponential death distribution up to a constant air - dry needle mass m_d.

During modelling of desiccation dynamics by the needles collected from other cardinal direction, and also for other accountable fir-trees similar results were obtained.

On obtained statistical models of desiccation a first passage time of a constant needle mass T and initial mass of a moisture in sample m_{m0} were estimated.

For all samples mean deliquification rate was estimated on expression:

$$V = m_{m0} / T \,, \qquad (2)$$

where V - the mean deliquification rate of needle sample, g/day; T - the first passage time of room air - dry mass m_d, days.

In table 2 the mean deliquification rates of fir-tree needle samples are represented.

In a fig. 2 the graph on experimental point, on which the modification of deliquification rate of collected fir-tree needle samples on four cardinal directions for four accountable fir-trees is shown, is represented.

Table 2. Mean deliquification rate of fir-tree needle samples

Number of an accountable fir-tree	Cardinal directions			
	North	South	East	West
1	0,026	0,034	0,014	0,026
2	0,019	0,030	0,024	0,022
3	0,013	0,020	0,011	0,019
4	0,020	0,025	0,022	0,010

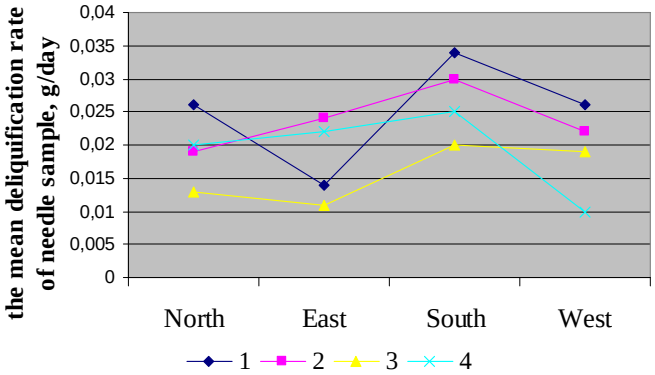

Fig. 2. The graph of a modification of accountable fir-tree needle sample deliquification rate

As it is visible in a fig. 2, the mean deliquification rate of the collected needle samples is unequal on cardinal directions. Apparently, on an azimuth the regular modification of a mean deliquification rate of needles occurs, that requires experiments on the all verticils at one height of fir-tree.

The indicated ecological parameter at different fir-trees changes considerably, that denotes good ecological informational content of an accepted parameter of a mean deliquification rate. Especially it is noticeably difference of a mean deliquification rate for trees № 2 and tree № 3. They can be compared on conditions of a habitat, influence of solar luminance and wind loading.

The obtained calculated significances of a mean deliquification rate of needles for fir-tree № 2 and fir-tree № 3 were compared on the Student′s test. In table 3 the results of a both sampling comparison are represented.

Table 3. Mean deliquification rate of needle samples at fir-tree № 2 and № 3

Mean deliquification rate		Student′s test	
Fir-tree № 2	Fir-tree № 3	estimated	table
0,0238	0,0158	2,4937	2,4469

As it is visible from data of table 3, an a mean deliquification rates for fir-tree № 2 and fir-tree № 3 differ considerably (for want of significance point more than 0,05).

Thus, in proportion to increase of distance from a road to fir-trees the mean deliquification rate of needle samples decreases considerably, that allows to use the given parameter for an evaluation of an ecological state of their habitat and other tree kinds growing about accountable fir-trees. And also on a mean deliquification rate of needle samples collected from fir-tree verticil ramules it will be possible judged about persistence of growing fir-trees and ecological relations on the ground areas of their habitat.

References

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