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# Regularities of the Distribution of the Wind Azimut and Trees Coordinates at the Stage of Growth of Birch Leaves During the Vegetation

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**Abstract:** *Formation and death of leaves in the cycle of ontogenesis are divided into the following stages: Bud growth and development of leaves, blooming dying leaves, leaf subsidence. We propose two more stages of ontogenesis – growth to the maximum and decline to the fall. The stage of growth of birch leaves hanging to the maximum width (similar to the length, area and perimeter of the leaves) of the growing season becomes a great quantum of plant behavior. This quantum with high adequacy shows that on three-time measurements of wind azimuth the distribution of the number of wind directions occurs according to the superstrong laws in 2014 and 2018. Then a three-hour quanta measurements of the azimuth of the winds make it very high to determine the adequacy of distribution of measurement directions of the wind.In 2014 had arisen three prevailing directions, growth of incidence azimuth: 45, 202.5 and 337.50. And in 2018 there were two directions of prevailing winds: 67.5 and 2700 in the city of Yoshkar-Ola. The three-hour distribution of wind directions along the azimuth at the first stage of the growing season of birch leaves from the first of may to August 20 of each year occurs according to clear laws, including wave equations with variable amplitude, changing according to the biotechnical law. For 2018, seven waves with a half-period of oscillations in the 45.1, 27.7, 23.25, 24.17, 0.23, 22.65 and 723 days. Of these, a constant period of 2 x 24.17 = 48.3 days. It is found that the influence of the distance from the road on the maximum width of the leaves has a correlation coefficient 0.7574, and the influence of the reduced East longitude on the same biometric parameter 0.7514. The average maximum width of the birch leaves can be a great indicator of pollution of the roadside area. To identify wave patterns, it is necessary to take more than 20 birches in different places.*

**Keywords:** *vegetation, growth stage to maximum, width, prevailing winds, wind azimuths, coordinates, distributions, vi-brational adaptation, regularities*

## 1. Introduction

Climate change affects the vegetation of the Earth. In Finland, there is an indication of the reaction of young deciduous trees to rising air temperatures in interaction with tropospheric ozone. This knowledge increases the chances of developing models to include parameters that describe the forest system in changing climatic conditions [9]. It can be argued that the future of CO2 containment lies in an increase in the area, primarily forests [10, 11]. The dynamics of carbon in Europe changes according to wavelets of universal design [7, 8]. In Berlin [1] 252 the tree of lime in the cores by the distance from the center to the periphery was revealed changes of the increment of the thickness of the trees for 50 to 100 years.

The understanding of modeling of mutual relations between the parameters of the plant leaf structure by the method of identification [5-7] comes. A priori it is clear that the weather affects the course of development and growth (ontogenesis) of plants. And perennials weather is affected through annual ontogenesis of leaves. The quanta of leaf behavior, for example, of the birch tree, widespread in the Northern hemisphere [15], clearly depend on the quanta (asymmetric wavelets [7, 8]) behavior of air temperature and relative humidity. Meteorological conditions are strong factors of activity of biological objects, and for this purpose in article [3] influence of temperature, precipitation, atmospheric pressure and humidity on phenology of amphibians in South-East Queensland (Australia) is estimated.

Plant growth is a complex process, it is based on such fundamental phenomena as rhythm, polarity, differentiation, irritability, correlation. These processes are common for ontogenesis. ***Ontogenesis*** – individual development of the body from zygote (or vegetative germ) to natural death. Because of the photosynthetic activity of the leaves, the plant acquires a number of features that characterize its growth. In the process of plant ontogenesis growth is observed during the main stages of its life cycle [2, 4, 10].

Formation and death of leaves in the cycle of ontogenesis are divided into the following stages: Bud growth and development of leaves, blooming dying leaves, leaf subsidence. We propose two more stages of ontogenesis – growth to the maximum and decline to the fall.

The growing season is becoming one of the important ecosystem processes, as the development of leaves is very sensitive to air temperature. Therefore, the future of climate is in leaf observations [11]. The metric parameters of the leaves depend on the growing season.

Birch hanging in Estonia proved to be effective against drought in 2010. Trees adapt well, and the importance of relative humidity is even higher compared to air temperature [13]. Increasing humidity reduces the temperature and biomass accumulation in young birches, especially susceptible leaves [14].

It can be argued that the future of $CO_2$ containment lies in an increase in the area, primarily forests [10, 11]. The dynamics of carbon in Europe changes according to wavelets of universal design [7, 8]. In ecological technologies with the use of birch leaves, the understanding of modeling of mutual relations between the parameters of the leaf structure by the identification method [5, 7] comes. A priori it is clear that the weather affects the course of development and growth (ontogenesis) of plants. And perennials weather is affected through annual ontogenesis of leaves. The quanta of leaf behavior, for example, of the birch tree, widespread in the Northern hemisphere, clearly depend on the quanta (asymmetric wavelets [7, 8]) behavior of air temperature and relative humidity. Meteorological conditions are strong factors of activity of biological objects, and for this purpose in article [3] influence of temperature, precipitation, atmospheric pressure and humidity is estimated.

The purpose of this article is to increase the accuracy of indication of the quality of the surrounding birch leaves local environment side at a height of 1.5 to 2.0 m from the side of the prevailing winds at the time of the growing season in 2018 from the first of may to the maximum width as the average of the 10 account if-stew the patent for the invention 2606189 depending on the distance from the edge of the road high you the location of the center of the zone 10 account leaves over the soil and given the geographical-ray coordinates of the location of the center of the butt end of trees.

## 2. Materials and Methods

The longest growing season since Bud break (may 2, 2014 and may 1, 2018) to the maximum leaf width was 111 days in 2014 (August 20) and 110 days in 2018 (August 18). For growth stages (Fig. 1) we accept dates from 01.05 to 20.08 and in three hours we will write down the data "wind Direction (Rumba) at an altitude of 10-12 meters above the earth's surface" for the weather station Yoshkar-Ola. Then the cells with "Calm" were excluded from the data array, and the Rumba were converted into azimuth.

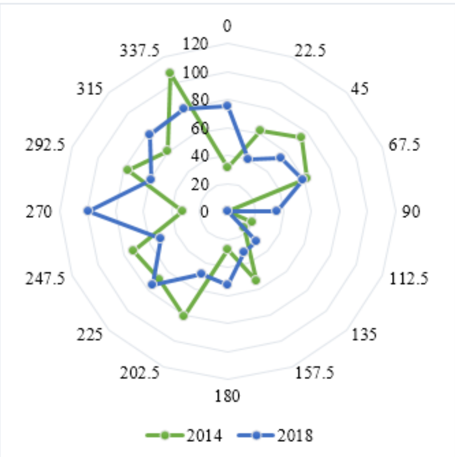



**Figure1.** *Wind rose in Yoshkar-Ola at the stage of growth during the growing season, birch hanging from 01.05 to 20.08*

In four years, the direction of prevailing winds shifted from $337.5^0$ to $270^0$. Then it can be argued that the direction of the winds is near the North-West.

Chart data in figure 1 are shown in table 1. Here are the residues (absolute error), as the difference between the actual and the calculated wave equations (table 2). And also in table 1 the values of the relative error are given, as the ratio (in percent) in the form of dividing the residues by the actual values of the wind azimuth.

**Table1.** *The direction of the winds at the stage of growth the leaves of the silver birch*

| Azimuth $\varphi$, degree | The number $N$ of rhombuses in wind direction units | | | | | |
|---|---|---|---|---|---|---|
| | Year 2014 | Tailings | Error | Year 2018 | Tailings | Error |
| 0 | 31 | -0.210962 | -0.68 | 75 | 0.104856 | **0.14** |
| 22.5 | 63 | 0.50304 | 0.80 | 40 | -0.0268786 | -0.07 |
| 45 | 75 | -0.714944 | -0.95 | 54 | 0.0306427 | 0.06 |
| 67.5 | 62 | 0.227208 | 0.37 | 58 | -0.0357718 | -0.06 |
| 90 | 0 | 0.196342 | - | 35 | 0.0314459 | 0.09 |
| 112.5 | 19 | -0.00369648 | -0.02 | 0 | -0.0262315 | - |
| 135 | 17 | -0.101437 | -0.60 | 30 | 0.0266313 | 0.09 |
| 157.5 | 54 | 0.227061 | 0.42 | 31 | 0.000856083 | 0.00 |
| 180 | 27 | 0.590869 | **2.19** | 53 | 0.00342509 | 0.01 |
| 202.5 | 81 | 0.0897795 | 0.11 | 48 | -0.0138827 | -0.03 |
| 225 | 69 | 0.0673064 | 0.10 | 75 | 0.00819107 | 0.01 |
| 247.5 | 73 | -0.0758387 | -0.10 | 51 | -0.011106 | -0.02 |
| 270 | 32 | -0.306591 | -0.96 | 99 | 0.0205141 | 0.02 |
| 292.5 | 77 | 0.0334596 | 0.04 | 59 | -0.0272314 | -0.05 |
| 315 | 61 | -0.0182502 | -0.03 | 78 | 0.0145546 | 0.02 |
| 337.5 | 107 | -0.455811 | -0.43 | 80 | -0.0386905 | -0.05 |
| Just | 848 | | | 866 | | |

Table 2 shows the distances from the road and soil, as well as the geographical and biometric parameters of 10 birches in Yoshkar-Ola on the average width of 10 leaves.

On each birch tree on the side of the crown from the prevailing winds (approximately North-West) there was a zone with a diameter of about 0.5 m, where 10 leaves were allocated, white threads with tags were tied to their tails, on which the numbers of the leaves were indicated. The reduced coordinate system was calculated as follows. With the help of a cell phone at first recorded the coordinates of the zone of accounting leaves (in degrees, minutes and seconds). Then these values resulted in degrees according to the formula PC = degree + minute / 60 + seconds /3600. The results read: North latitude origin $-56.6^0$; East longitude origin $-47.8^0$. However, for the Curve Expert 1.40 software environment, you must multiply the obtained values of the reduced coordinates by 100.

**Table 2.** *Birch trees location parameters with 10 checklists on each tree*

| Place record birches | Distances $L$ and $h$, m | | Coordinate System birches | | Reducedcoordinatesystem$10^{-2}$, $^0$ | | Time vegetations $\tau$, day | Maximum width, $\bar{b}_{max}$, mm |
|---|---|---|---|---|---|---|---|---|
| | road | soil | Northernlatitude | Eastern longitude | Northernlatitude $\alpha$ | Eastern longitude $\beta$ | | |
| 1. LebedevStreet | 7.0 | 1.60 | 56°37′ 6″ | 47°56′ 48″ | 1.833 | 14.667 | 110 | 45.92 |
| 2.Voskresenskypros. | 2.9 | 1.46 | 56°38′6″ | 47°54′51″ | 3.500 | 11.417 | 110 | 48.66 |
| 3.StreetEshkinina | 5.2 | 1.40 | 56°37′ 58″ | 47°54′ 47″ | 3.278 | 11.306 | 92 | 39.77 |
| 4. Leninavenue | 4.9 | 1.60 | 56°38′ 8″ | 47°53′ 12″ | 3.556 | 8.667 | 99 | 40.11 |
| 5.ChawainBoulevard | 2.1 | 1.60 | 56°37′ 52″ | 47°54′ 47″ | 3.111 | 11.306 | 106 | 44.71 |
| 6. Panfilov Street | 4.1 | 1.30 | 56°37′ 40″ | 47°52′ 55″ | 2.778 | 8.194 | 103 | 39.56 |
| 7.Karl Marx | 3.2 | 1.6 | 56°36′ 47″ | 47°52′ | 1.306 | 7.917 | 99 | 44.39 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Street | | 0 | | 45″ | | | | |
| 8. BuildersStreet | 4.3 | 1.4 5 | 56°36′ 54″ | 47°52′ 5″ | 1.500 | 6.806 | 103 | 42.25 |
| 9. Botanicalgarden | 2.4 | 1.5 5 | 56°38′ 42″ | 47°52′ 50″ | 4.500 | 8.056 | 103 | 40.71 |
| 10. OsipenkoStreet | 2.3 | 1.4 5 | 56°38′ 42″ | 47°52′ 50″ | 4.500 | 8.056 | 99 | 44.09 |

Oscillations (wavelet signals) are recorded by the wave formula [5-7] of the form

$$y_i = A_i \cos(\pi x / p_i - a_{8i}),\ A_i = a_{1i} x^{a_{2i}} \exp(-a_{3i} x^{a_{4i}}),\ p_i = a_{5i} + a_{6i} x^{a_{7i}}, \quad (1)$$

where $y$ – the index (dependent factor), $i$ – номер components of the model (1), $m$ – number of members in the model (1), $x$ – explanatory variable (influencing factor), $a_1 ... a_8$ – the parameters of the model (1) taking the numerical values in the course of structural-parametric identification in the software environment Curve Expert-1.40 (URL: http://www.curveexpert.net/), $A_i$ – amplitude (half) of wavelet (axis $y$), $p_i$ – the half-period fluctuations (axis $x$).

## 3. Results and Discussion

Table 3 gives the parameters (1) according to table 1.

The first term models with parameters from table 2 is the law of Laplace (in math), Mandelbrot (in physics), texts-pearl (biology) and Pareto (econometrics). But different directions: for 2014 it is the law of exponential growth, and for 2018 – exponential death. This natural law changes for wind directions depending on the azimuth with correlation coefficients 0.5865 and 0.8000. This fact indicates that the growth stage of the growing season of 2018 was better in wind directions. The second term of the trend is a biotechnical law [5]. All vibrations have a very high value. It is this property of oscillation that indicates that plants have adapted to wave changes in meteorological parameters over hundreds of millions of evolutions.

**Table3.** *Options (1) directions of the wind azimuths in growing birch leaves*

| Number $i$ | Wavelet $y_i = a_{1i} x^{a_{2i}} \exp(-a_{3i} x^{a_{4i}}) \cos(\pi x / (a_{5i} + a_{6i} x^{a_{7i}}) - a_{8i})$ | | | | | | | | Coef. corr. $r$ |
|---|---|---|---|---|---|---|---|---|---|
| | The amplitude (half) the fluctuations | | | | The half-period of oscillations | | | Shift | |
| | $a_{1i}$ | $a_{2i}$ | $a_{3i}$ | $a_{4i}$ | $a_{5i}$ | $a_{6i}$ | $a_{7i}$ | $a_{8i}$ | |
| Growth stage of the growing season 2014 | | | | | | | | | |
| 1 | 31.04888 | 0 | -0.0022750 | 1 | 0 | 0 | 0 | 0 | 0.8559 |
| 2 | 4.06016e-18 | 26.00798 | 56.02962 | 0.11207 | 0 | 0 | 0 | 0 | |
| 3 | 43.62256 | 0 | 0.00025496 | 1.51089 | -439.5006 | 479.37559 | 0.016749 | 1.61580 | |
| 4 | -0.24363 | 1.10734 | 0.0094773 | 1 | 41.19066 | 0 | 0 | 1.12850 | 0.5645 |
| 5 | 8.84433e-7 | 3.96058 | 0.011097 | 1.10024 | 26.21567 | -0.00019902 | 1.67304 | 1.62260 | 0.9919 |
| 6 | -3.00032e-26 | 13.75107 | 0.063782 | 1.00350 | 43.87951 | 0.00014347 | 1.84964 | 0.061472 | 0.7472 |
| 7 | 4.56629 | 0 | 0.014893 | 1 | 72.84731 | -0.013148 | 1 | -1.08682 | 0.9478 |
| Growth stage of the growing season 2018 | | | | | | | | | |
| 1 | 84.77647 | 0 | 0.011844 | 1 | 0 | 0 | 0 | 0 | 0.8895 |
| 2 | 9.43003e6 | 41.69824 | 96.48688 | 0.16659 | 0 | 0 | 0 | 0 | |
| 3 | 32.51765 | 0 | 0.0071364 | 1 | 45.13786 | 0.00018205 | 2.04081 | 4.43375 | |
| 4 | -4.32383e-13 | 7.19338 | 0.0060364 | 1.29657 | 27.72950 | -0.00045090 | 1.62188 | -4.77571 | 0.9865 |
| 5 | -1.35019 | 0 | -0.00039237 | 1.34949 | 23.24999 | 0.057855 | 0.99288 | 5.47970 | 0.9551 |
| 6 | -0.36915 | 0.035157 | 0.00012797 | 1.36144 | 24.16514 | 0 | 0 | -0.31166 | 0.4996 |
| 7 | -1.41559 | 0.047326 | 0.0062964 | 1 | 0.23369 | 0.024887 | 1 | 5.71216 | 0.7413 |
| 8 | 4.71860 | 17.24510 | 0.073747 | 1.00392 | 22.64515 | 0.027914 | 0.98229 | 1.69285 | 0.9329 |
| 9 | 1.71127e-6 | 5.45479 | 0.56047 | 0.61560 | 722.97994 | 6.84720 | 1.18444 | -1.45528 | 0.9157 |

Figures 1 and 2 show graphs of all components of the General model (1).

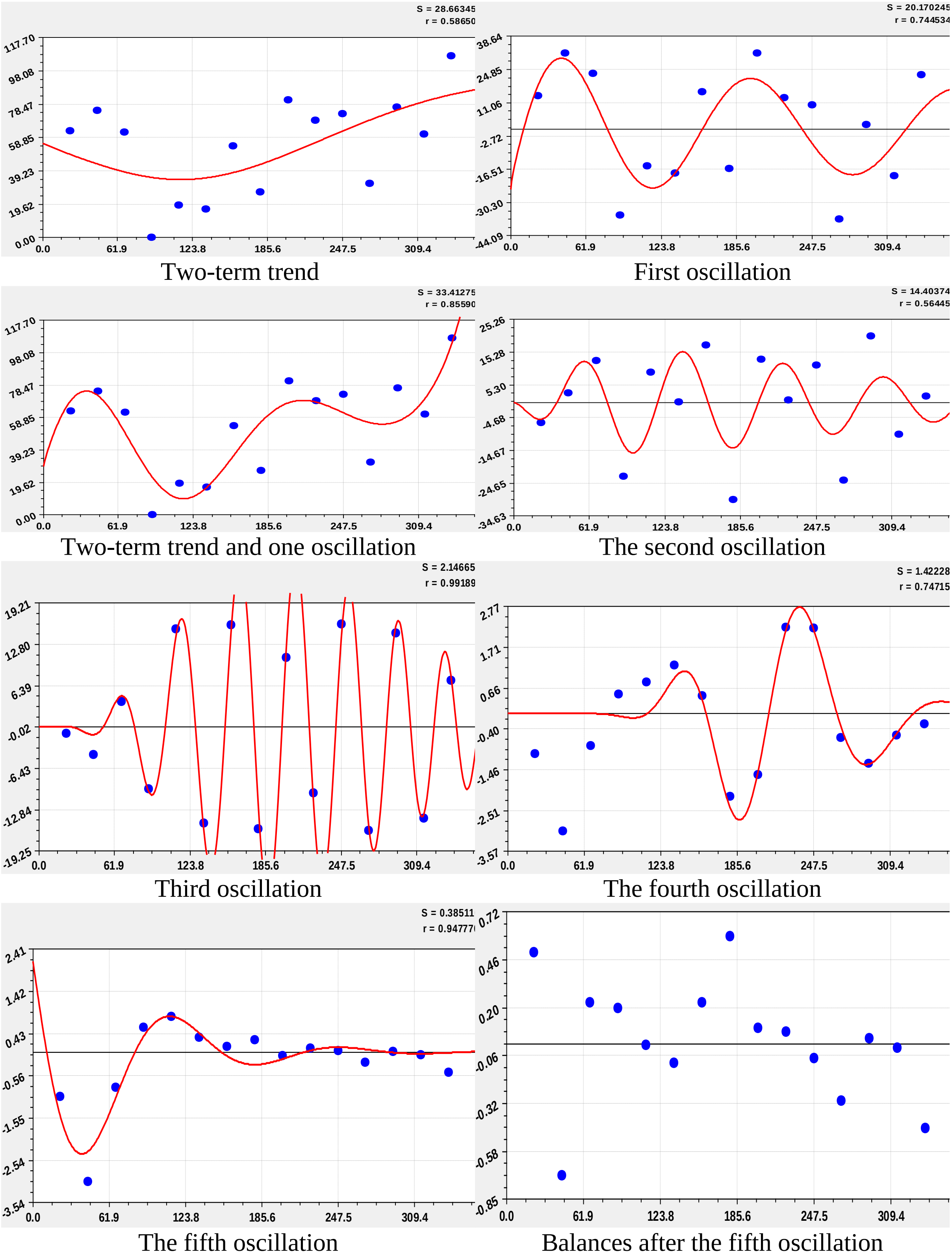



**Figure1.** *Graphics wavelets of the directions of the wind in 2014, the growth stage of the leaves*

The maximum relative error in table 1 is 2.19% for 2014 and 0.14% for 2018. At the same time, the first three members obtained by the capabilities of the Curve Expert-1.40 software environment received a correlation coefficient of 0.8559 and 0.8859. All five fluctuations in the growth phase of 2014 ended before August 20, when there was a maximum of average width.

For the growth phase in 2018 (Fig. 2) there were seven oscillations.

Of these, only the fourth oscillation continued after 20.08. The fifth oscillation shows that the growing season began in the directions of winds spontaneously, and then the period of oscillation increased.

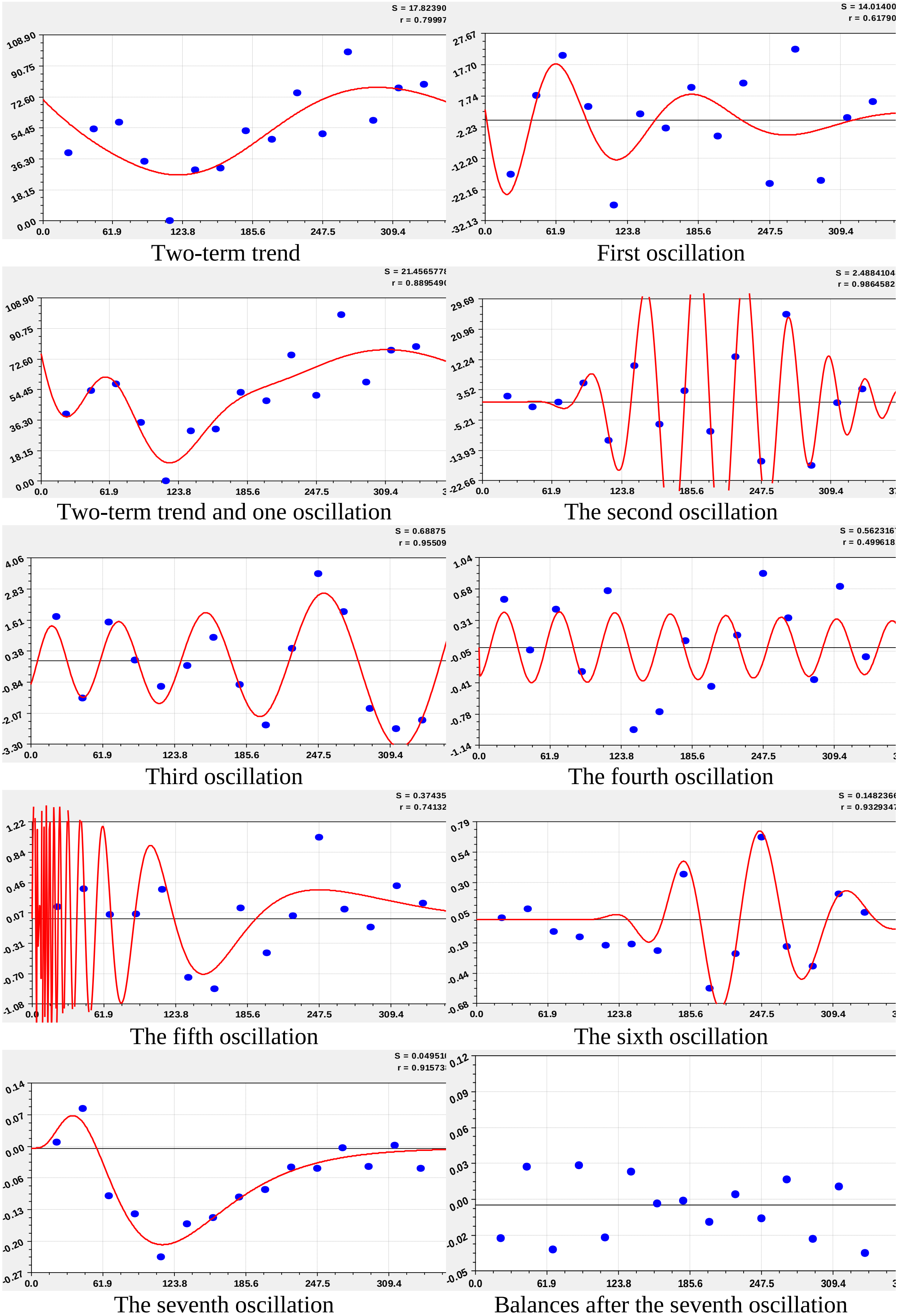



**Figure2.** *Graphics wavelets of the directions of the wind in 2018, at the growth stage of the leaves*

The law of stress excitation for the second term from table 2 shows that, apparently, the wind direction stimulates the growth of vegetative organs of plants. This was facilitated by the third oscillation (fifth term) with a correlation coefficient of 0.9919 in 2014. And in 2018, the strengthening of the vibrational adaptation of leaf growth was due to the second member (biotechnical law) and the fourth member of the strongest adequacy (0.9865).

Thus, we have proved that the three-hour distribution of wind directions along the azimuth at the first stage of the vegetation period of birch leaves from the first of may to August 20 of each year occurs according to clear laws, including wave equations with variable amplitude, changing according to the biotechnical law.

The period of oscillation varies in a wide range. It is not clear why the first fluctuation in 2014 occurred with a negative period of 2 x (-439.5) = -879 days. The remaining waves had periods of 82.4, 52.4, 87.8 and 145.7 days. Half-life of 41.2 days is constant for the whole stage of leaf growth in 2014 and is close to 40 days of weather.

For 2018, seven waves with a half-period of oscillations in the 45.1, 27.7, 23.25, 24.17, 0.23, 22.65 and 723 days. Of these, a constant period of 2 x 24.17 = 48.3 days. Start account leaves the latest fluctuation shows that the maximum half life for 01.05.2018 the wind directions is equal to 723 days. The stage of growth of birch leaves in 2018 was more complicated than in 2014 due to the emergence of the fifth and seventh oscillations. Such uncertainties are likely to increase in the future.

Analysis of the three charts shows that in 2014, there have been three prevailing wind directions, in ascending order of frequency of occurrence of the azimuth of the winds: 45, 202.5 and 337.5$^0$.And in 2018, only two directions of prevailing winds were formed: 67.5 and 270$^0$. It is characteristic that out of 848 wind directions at the stage of growth of birch leaves in 2014 there was not a single case in the direction of the azimuth 90$^0$, and in 2018 zero events out of 866 – in the azimuth 112.5$^0$.

Table 4 presents the results of the factor analysis according to table 24. Here are the factors $L$, $h$, $\alpha$ and $\beta$ are the only influencing variables, so the horses can't become dependent parameters. The factors $\tau$ and $\bar{b}_{\max}$ become both influencing and dependent parameters, so they can be ranked by the pre-order vector of preference «better $\rightarrow$worse». For both of the biometric parameters $\tau$ and $\bar{b}_{\max}$ vector accepted «the more the better»

**Table4.** *Correlation matrix of factor analysis and rating of factors after identification by trend pattern*

| Influencing factors (characteristic $x$) | Dependent factors (indicators $y$) | | Amount $\Sigma r$ | Place $I_x$ |
|---|---|---|---|---|
| | $\tau$, day | $\bar{b}_{\max}$, mm | | |
| Distance of the group leaves from the road $L$, m | 0.0021 | 0.7574 | 0.7595 | 4 |
| The height of the group leaves from the soil $h$, m | 0.2360 | 0.4640 | 0.7000 | 5 |
| GiventheNorthernlatitude $\alpha$, $^0$ | 0.1582 | 0.1656 | 0.3238 | 6 |
| Eastlongitudegiven $\beta$, $^0$ | 0.5326 | 0.7540 | 1.2866 | 3 |
| Times of growth accounting leaves $\tau$, day | 0.9912 | 0.6804 | 1.6716 | **1** |
| The average width of the leaves account $\bar{b}_{\max}$, mm | 0.6793 | 0.9852 | 1.6645 | 2 |
| The sum of the correlation coefficients $\Sigma r$ | 2.5994 | 3.8066 | 6.4060 | - |
| Place $I_y$ | 2 | **1** | - | 0.5338 |

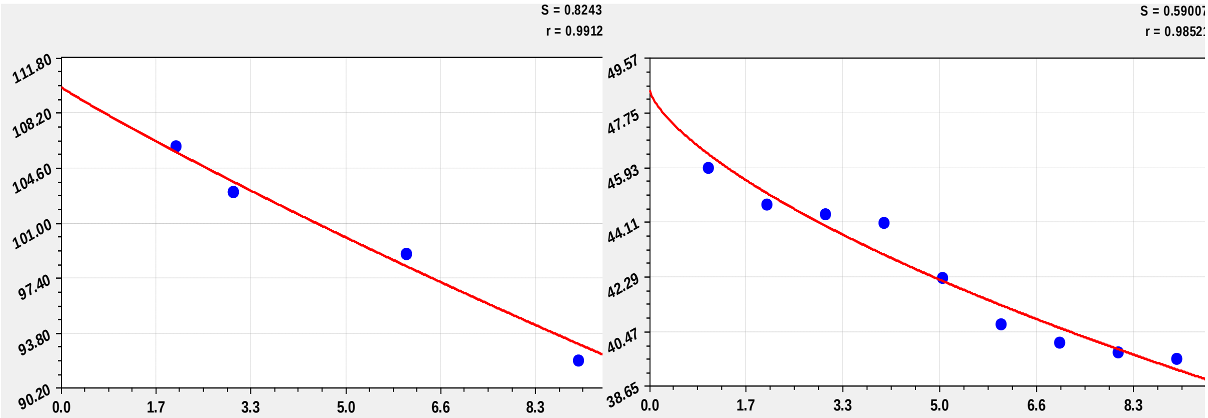
Then the rank distribution will obey the law of exponential death at ranks (Fig. 3) by formulas

- for the rank distribution of vegetation time of accounting leaves in 10 birches (0.9912)

$$\tau = 109.86894\exp(-0.020293R_{\tau}^{0.95603}); \qquad (2)$$

- for an average width of 10 leaves for each of the 10 birch trees (0.9852)

$$\bar{b}_{\max} = 48.51034\exp(-0.044851R_{b}^{0.70910}). \qquad (3)$$




Time of the growing season to reach maximum growth  The average maximum width of the sheet

**Figure3.** *Graphs of rank distribution of biometric parameters of birch leaves*

Table 4 shows the results of factor analysis using the trend as a special case of formula (1) with an infinite period of oscillation.

The coefficient of correlation variation, as a measure of the adequacy of the entire system of parameters of the object of study, is defined as 6.4060 / (6 x 2) = 0.5338. The first place among the influencing variables is the growing season until the end of the growth stage, and the second – the average width of the leaves at the maximum growth of leaves.  Among the dependent indicators as evaluation criteria is the average width of the leaves at the end of the growth stage.

Choose the correlation matrix (tab. 5) with medium and strong binary relations with a correlation coefficient of at least 0.5. The greatest correlation coefficient 0.7574 has the effect of the distance from the approximate center of the zone of 10 leaves on the lateral surface of the crown of birch hanging from the prevailing winds (North-West) to the edge of the road.

**Table5.** *Correlation matrix with correlation coefficient not less than 0.5*

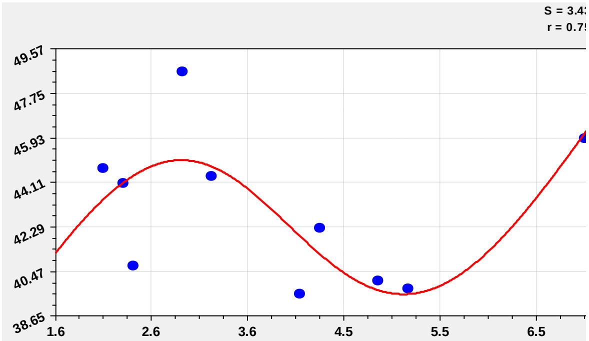
| Influencingfactors (characteristic $x$) | Indicators $y$ | |
|---|---|---|
| | $\tau$, day | $\bar{b}_{\max}$, mm |
| Distance of the group leaves from the road $L$, m | | 0.7574 |
| Eastlongitudegiven $\beta$, $^0$ | 0.5326 | 0.7540 |
| Times of growth accounting leaves $\tau$, day | | 0.6804 |
| The average width of the leaves account $\bar{b}_{\max}$, mm | 0.6793 | |

In table 6, we place the trend models in descending order of adequacy.

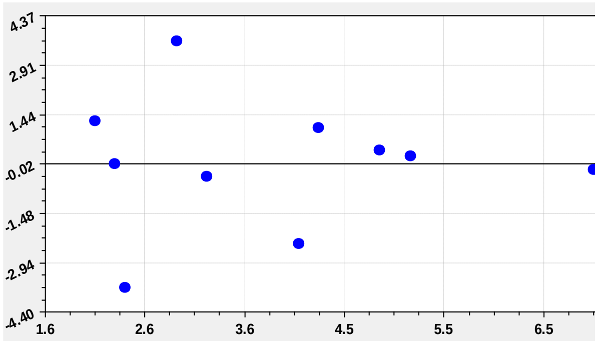
**Table6.** *Options trend binary relations data on table 2*

| Variable $x$ | Indicator $y$ | Trend $y = a\exp(-bx^c) + dx^e\exp(-fx^g)$ | | | | | | | Coef. Corr. $r$ |
|---|---|---|---|---|---|---|---|---|---|
| | | Exponentiallaw | | | Biotechnicallaw | | | | |
| | | $a$ | $b$ | $c$ | $d$ | $e$ | $f$ | $g$ | |
| $L$, m | $\bar{b}_{\max}$, mm | 0.27696 | -4.90586 | 0.041252 | -2.506947 | 25.06937 | 27.20913 | 0.43559 | 0.7574 |
| $\beta$, $^0$ | | 47.77710 | 6.90355e-5 | 3.64290 | 8.14379e-140 | 185.8460 | 6.73438 | 1.21378 | 0.7514 |
| $\tau$, day | | 0 | 0 | 0 | 0.65415 | 0.90434 | 0 | 0 | 0.6804 |
| $\bar{b}_{\max}$, mm | $\tau$, day | 0 | 0 | 0 | 14.42463 | 0.52119 | 0 | 0 | 0.6793 |
| $\beta$, $^0$ | | 204.11047 | 0.29180 | 1 | 30.74222 | 0.46543 | 0 | 0 | 0.5325 |

Figure 4 shows graphs of the effect of the distance from the road to the leaves.




Two-termtrend




Residues from two members of the trend

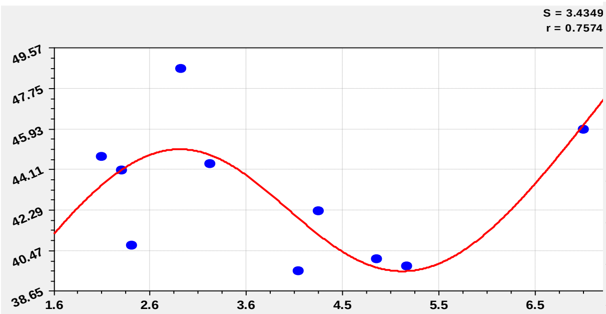
**Figure4.** *Graphs of the influence of the distance from the road on the average max. width of the leaf group*

From the point chart of residues it can be seen that the oscillation is possible (tab. 7, Fig. 5). Due to the small number of points the correlation coefficient of the three-membered model became equal to 1.0000.

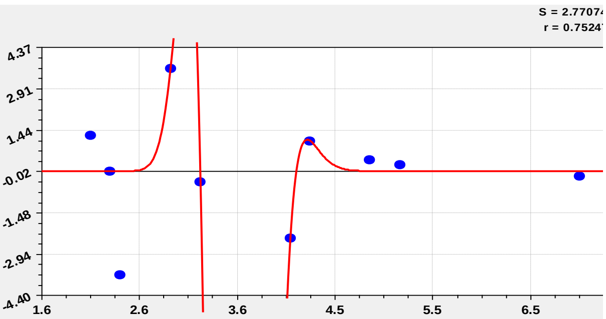
**Table7.** *Models (1) the effect of distance from the road on the max.of the average width of the sheet*

| Number $i$ | Wavelet $y_i = a_{1i}x^{a_{2i}}\exp(-a_{3i}x^{a_{4i}})\cos(\pi x/(a_{5i}+a_{6i}x^{a_{7i}})-a_{8i})$ | | | | | | | | Coef. Corr. $r$ |
|---|---|---|---|---|---|---|---|---|---|
| | The amplitude (half) the fluctuations | | | | The half-period of oscillations | | | Shift | |
| | $a_{1i}$ | $a_{2i}$ | $a_{3i}$ | $a_{4i}$ | $a_{5i}$ | $a_{6i}$ | $a_{7i}$ | $a_{8i}$ | |
| 1 | 5.77155 | 0 | -1.96504 | 0.041252 | 0 | 0 | 0 | 0 | 1.0000 |
| 2 | -5.59056e9 | 25.07757 | 30.15966 | 0.43558 | 0 | 0 | 0 | 0 | |
| 3 | -3.34826e-20 | 174.83658 | 46.85684 | 1.02318 | 0.81421 | 4.65539e-5 | 4.22651 | 1.29874 | |
| 4 | 2308.83874 | 0 | 1.47595 | 1.73980 | 0.022770 | 0.021648 | 1.01222 | 3.29490 | 0.9523 |

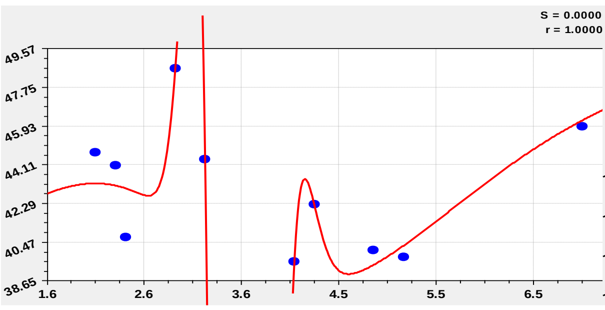
The average maximum width of the birch leaves can be a great indicator of pollution of the roadside area. To identify wave patterns, it is necessary to take more than 20 birches in different places.



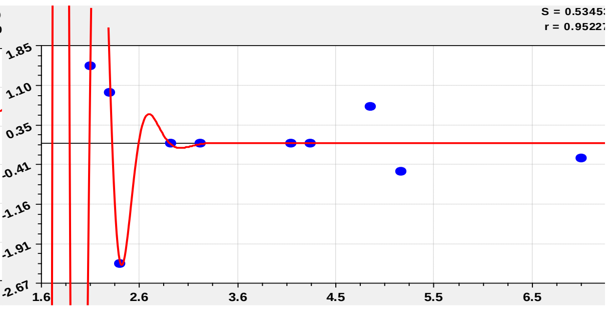

Two-termtrend




Firstoscillation




Two-term trend and one oscillation

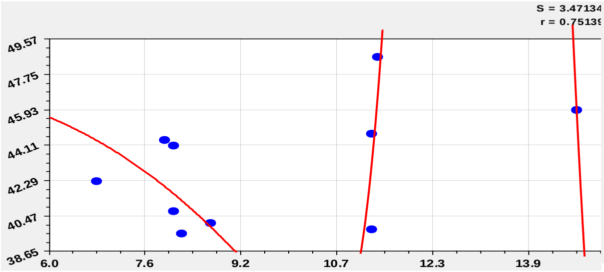



Thesecondoscillation

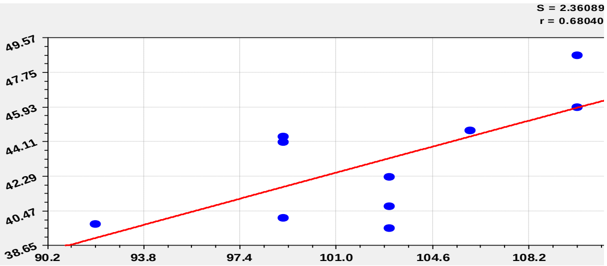
**Figure5.** *Graphs of the influence of the distance from the road on the average max. width of the leaf group*

The greatest turbulence is observed up to 3 m from the edge of the road. Here, according to the trend, the maximum of the average width is observed. And then from 3 m to 5 m, there is a decrease in the width of the leaf, that is, in this distance from the road, there is a strong suppression of the vegetation of the leaves. After 5 m birch leaves begin to grow with the increasing width of the leaves.

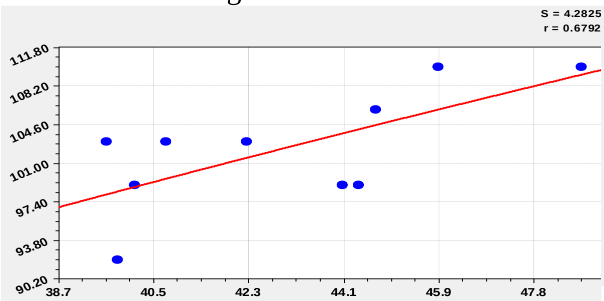
The rest of the patterns from table 4 are shown in figure 6.



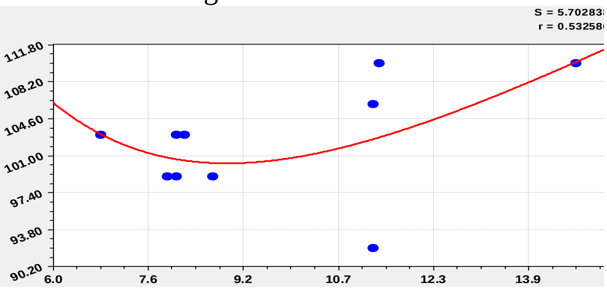

The effect of longitude at the maximum width




The time of vegetation to the maximum width




Maximum width during the growing season




The effect of longitude on time of the growing season

**Figure6.** *Graphs of binary relations according to table 4*

Direct and reverse influence of biometric parameters of leaves according to table 7 occur according to the exponential law. Let's take a closer look at the influence of East longitude.

According to the schedule in figure 6, the decrease in vegetation time occurs in the Central district of Yoshkar-Ola. The most difficult way to change the schedule of long-term impact on the average maximum width of the leaves. Figure 7 shows a schematic map of 10 birch trees. It is seen that the main transect is obtained along the river Malaya Kokshaga.

**Figure7.** *Map-scheme of location of accounting 10 trees silver birch*

Thus, the maximum width of the accounting leaves decreases from West to East on the right side of the city to the river, and on the left side of the river, the increment of the width of the leaves increases sharply, but again decreases in areas with high-rise buildings.

## 4. Conclusion

Thus, the stage of growth of birch leaves hanging to the maximum width (similar to the length, area and perimeter of the leaves) of the growing season is a great quantum of plant behavior. This quantum with high adequacy shows that according to the three-hour measurement of the wind azimuth, the distribution of the number of wind directions occurs according to super-strong laws in 2014 and 2018. Then a three-hour quanta measurements of the azimuth of the winds make it very high to determine the adequacy of distribution of measurement directions of the wind.

In 2014, there were three predominant directions in the growth of azimuth occurrence: 45, 202.5 and $337.5^0$. And in 2018 there were two directions of prevailing winds: 67.5 and $270^0$.

The average maximum width of the birch leaves can be a great indicator of pollution of the roadside area. To identify wave patterns, it is necessary to take more than 20 birches in different places.

On each birch tree on the side of the crown from the prevailing winds allocated area where 10 accounting leaves, and to their roots tied white thread with tags and numbers. Cell phone recorded the coordinates of the zone of leaves. Then the given coordinates were calculated. For the Curve Expert 1.40 software environment, multiply the obtained values of the reduced coordinates by 100.

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