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STUDYING THE DROUGHT-RESISTANCE OF BERRY PLANTS

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***ABSTRACT**--The article presents the data about drought-resistance of berry fruits cultivars, such as strawberry and golden currant, and also studies the water amount and water deficiency on the leaves of strawberry and golden currant cultivars which belong to different ecological groups. Having taken the samples of the leaves of strawberry and golden currant before irrigation and after irrigation in experimental fields of investigation, the air temperature, its relative humidity, the influence of water amount and soil moisture on water deficiency have been studied too.*

***Keywords**-- strawberry, golden currant, varieties, temperature, relative humidity, soil moisture, water amount on leaves, water deficiency.*

I. INTRODUCTION

The changes in global climate may result in various danger or disasters and drought in nature. Today's science has acknowledged that water cannot be substituted by anything in future even though the food products and non-renewed natural resources can be substituted by the products that are produced unnaturally. Therefore, the decreasing amount of fresh water in our planet may cause a great danger. This is due to the pollution of fresh water, mainly, the groundwater, river and lake water is polluted with various chemical compounds [6, 8, 9, 10].

Nowadays water deficiency and the amount of irrigation water are limiting factors for enlarging farming croplands and increasing productivity.

Water deficiency damages much to most plants. Water deficiency, that is, drought firstly has an adverse effect on water metabolism process of the plants and other physiological processes (photosynthesis, respiration, absorption of mineral nutrients through roots, metabolism of the substances of plant body and others) on the plants. In result, the growth and development of plants slow down or stop completely [5,7].

It has been observed in Uzbekistan condition that the non-resistant crop varieties to heat and drought in summer months and to last frost cold in spring are mostly damaged and produce less quality yield [1, 2].

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II. MATERIALS AND METHODS

Drought-resistance of strawberry and golden currant cultivars was determined by the method of E.A. Goncharova (1988) [3].

In order to identify water deficiency on leaves (WDL) and water amount on leaves (WAL), the leaves of golden currant located on the 7-10th nodes of one year old shoots were taken in the morning at 6^{00}, then at noon time at 14^{00} when the weather is too hot and air humidity is too low, and also at 18^{00} in the evening for testing. At the same time water deficiency in the middle part of one year old shoots (30-50 cm shoots) and water amount were determined. Water deficiency of leaves and shoots (%) was calculated according to this formulae:

$$WD = \frac{(AW \times 100)}{CW}$$

here: WD – water deficiency; AW – absorbed water, the difference between the masses of leaves before water absorption and after absorption; CW – current water, the difference between dry mass of leaves and water absorbed mass of leaves.

Water amount of the leaves and shoots (%) is calculated by the following formulae:

$$WA\% = \frac{(B_1 - B_2)}{B_1} \times 100$$

here: WA % - water amount, B_1- primary mass of leaf or shoots, B_2 – dry mass of leaf or shoots.

Newly germinated leaves of strawberry were taken from one year old strawberry bed for testing.

All data obtained from the results of investigation was analyzed with correlation on the basis of the method of B.A. Dospekhov under Excel programme [4].

Correlation level was estimated by its power. According to influencing power the relations can be: strong, medium, and weak. Correlation coefficient is likely to be from 0 to +1 positive in good correlation, while in contrary correlaton it is from 0 to -1 negative. Correlation coefficient with 0 indication shows the absence of interrelation between the studied phenomena. The connection is calculated with correlation coefficient. Correlation level of the results of investigation was marked with colors. They are: light yellow, green, dark red, and zero connection was marked with grey color.

Table 1: Coefficient of correlation

Correlation evaluation	Conditional color	Coefficient of correlation	
		Good correlation (+)	Contrary correlation (-)
little (weak)		from 0 to 0,30	from 0 to 0,30
Medium		from 0,3 to 0,7	from 0,3 to 0,7
large strong		from 0,7 to 1	from 0,7 to 1
no connection		0	0

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III. RESULTS AND DISCUSSION

In order to determine the drought period during 2017-2019, climatic-diagram was created for average precipitation amount and mean temperature of air on the base of hydrometeorological data of 3 years. According to it, the precipitation decreased minimally from January to June. A mean air temperature increased maximally from February to July. Marked lines of diagram on precipitation amount and mean air temperature have crossed at the 2nd decade of May. From the 3rd decade of August the precipitation has started rising. Mean air temperature has started decreasing from August. Marked lines on precipitation amount and mean air temperature have crossed at the 3rd decade of August. Apparently, in 2018 from the 2nd decade of May to the 3rd decade of August, the drought period was observed (Figure 1).

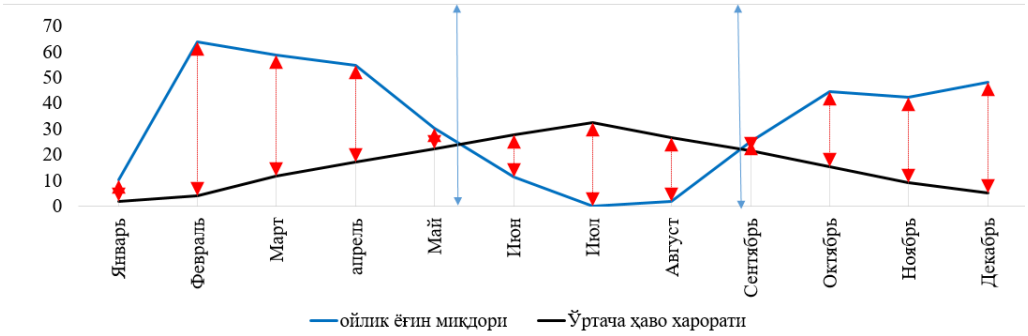

Figure1 : Phenological climatic-diagram of investigated area (average in 2017-2019)

Soil moisture of experimental field for strawberry and golden currant cultivars was studied before and after irrigation procedures of this field. Soil moisture of the fields was indicated in table-2 and table-3.

Table 2 : Soil moisture in the field of experience of strawberry varieties, % (average in 0-60 cm depth, in 2017-2019)

№	Date	After irrigation	Before irrigation
1	June	18,5	14,5
2	July	18,2	13,5
3	August	19,2	13,6

Table 3: Soil moisture in the field of experience of golden currant, % (average in 0-100 cm depth, in 2017-2019)

№	Date	After irrigation	Before irrigation
1	June	19,6	14,2
2	July	19,5	12,4
3	August	20,8	13,6

The data on air temperature and relative air humidity observed during vegetation period of golden currant cultivars in experimental field was almost similar with average indications of many years during summer. It was also observed that the indications on air temperature obtained at daytime were higher than those that were taken in

the morning and evenings, while relative humidity was lower at that time. Temperature and relative humidity of air of experimental fields for strawberry and golden currant varieties were presented in table 4 and 5.

Table 4: Air temperature and relative humidity in experimental fields of strawberry varieties (average in 2017-2019)

Date	After irrigation						Before irrigation					
	06-00		13-00		18-00		06-00		13-00		18-00	
	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %
June	22,2	85,0	32,3	72,0	32,2	79,7	24,8	74,3	35,0	63,7	33,4	66,7
July	24,0	78,7	35,3	66,0	30,7	68,3	22,0	81,3	36,7	64,7	31,7	71,7
August	21,5	86,7	34,8	64,7	32,0	73,0	22,0	83,0	35,8	64,3	31,3	72,0

Table 5: Air temperature and relative humidity in experimental fields of golden currant varieties (average in 2017-2019)

Date	After irrigation						Before irrigation					
	06-00		13-00		18-00		06-00		13-00		18-00	
	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %	Temperature, °C	Relative humidity, %
June	19,1	80,0	34,0	61,5	30,7	67,5	25,3	70,3	36,3	63,0	32,1	69,0
July	22,7	80,3	35,5	65,7	32,0	64,0	23,3	78,3	37,3	65,3	32,3	67,7
August	21,5	89,3	34,8	69,7	33,3	76,7	19,2	87,3	35,7	69,3	31,8	74,0

One of the most important indications in physiological process of plant in summer is water amount on this plant.

It was determined that water amount on the leaves of strawberry cultivars can change during vegetation period and depending on varieties having no sustainable indications.

Water amount of leaves of strawberry cultivars which were selected for investigation has changed during vegetation depending on soil moisture, air temperature, relative humidity of air and also photoperiod, these indications were found to be different according to plant varieties.

In June month before irrigation procedures in experimental fields the water amount of the leaves of strawberry varieties was a bit higher in Uzbekistanskaya and Bountiful varieties in accordance with the results obtained from the samples in the morning at 6:00, at noon at 13:00 and in the evening at 18:00. In July and August the water amount of Bountiful variety remained in high level. Particularly, the highest indications of maximal amount of

water of the leaves was observed in the morning time, at the contrary, in the second half of the day at 13^{00} o'clock it decreased and by the evening time a rise was again observed (Figure-2).

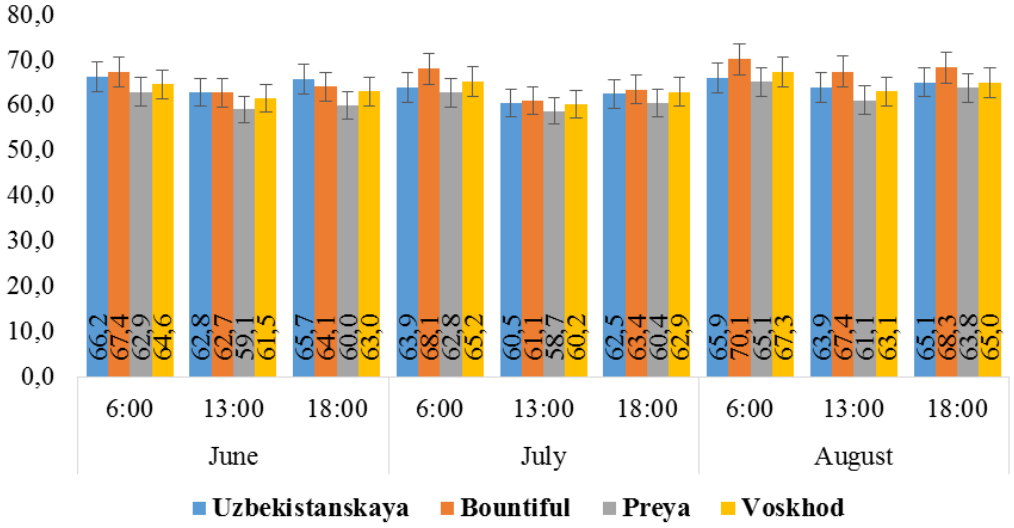

Figure 2: Water amount of the leaves of strawberry cultivars (before irrigation), % (in 2017-2019)

After irrigation, the water amount on the leaves of strawberry cultivars increased in the morning, while at noon time when the weather was too hot it decreased accordingly, in the evening time it again raised. Maximal water amount was observed in Bountiful and Voskhod varieties comparing to other varieties.

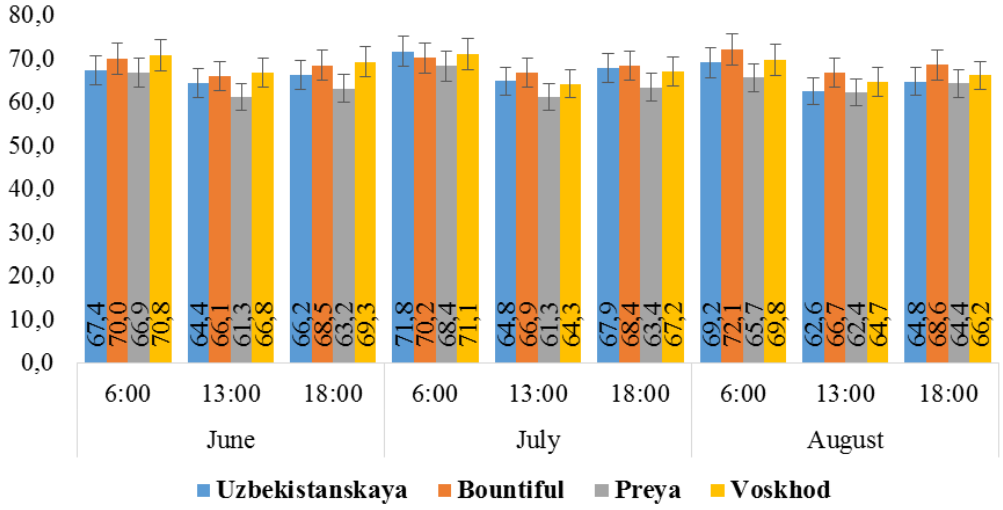

Figure 3: Water amount on the leaves of strawberry cultivars (after irrigation), % (in 2017-2019)

In the results of the experiments conducted in strawberry field before irrigation the water amount of the leaves of all strawberry cultivars was found to be lower than the indications after irrigation.

It is important to study the requirement of the leaves of strawberry cultivars for water and its changes during vegetation depending on cultivars.

According to the results of investigation, the cultivars with the highest water deficiency Voskhod (59,1%) and Uzbekistanskaya (55,7 %) were observed in the experiment carried out at 13:00 daytime, in July before the irrigation of the field.

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Another cultivars with less water deficiency on the leaves were Bountiful (18,8%) and Preya (20,1%) varieties (Figure-4).

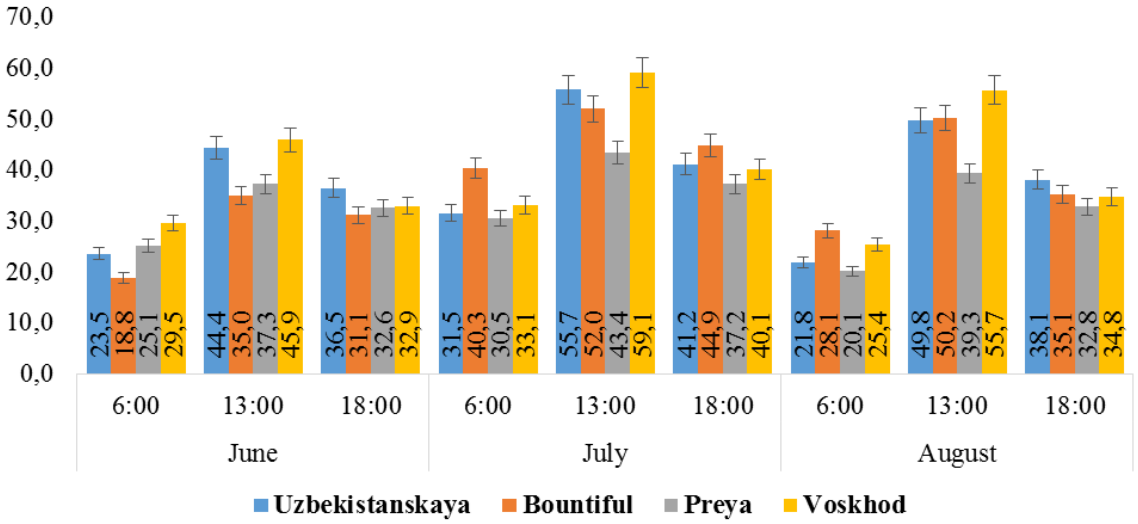

Figure 4: Water deficiency on the leaves of strawberry cultivars (before irrigation), % (in 2017-2019)

After conducting irrigation procedures in the field the water deficiency was again checked on the leaves and the highest indication was noted in July month at daytime with Uzbekistanskaya (47,9 %) variety. The least water deficiency was noted in August with Bountiful (11,9 %) variety (Figure-5).

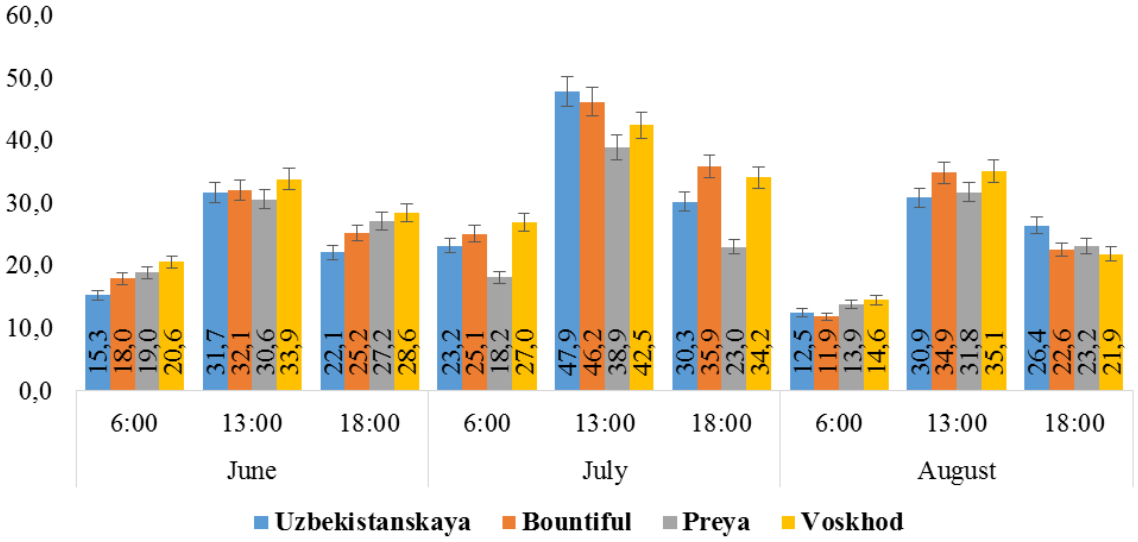

Figure 5: Water deficiency on the leaves of strawberry cultivars (after irrigation), % (in 2017-2019)

In the result of the analysis from the aforementioned investigations the connection of water deficiency of strawberry cultivars with air temperature, relative humidity of air, water amount of the leaves and soil moisture was evaluated with correlation.

It was identified that there was positive correlation connection between water deficiency on all varieties of strawberry and air temperature. In Bountiful cultivar a mean positive connection (0,6) was noted before irrigation,

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while in all other cultivars a strong positive connection (0,8 and 0,9) was observed before irrigation and after irrigation. The more air temperature rose, the more water deficiency increased.

Correlation connection between water deficiency of strawberry cultivars and relative humidity of air was found to be negative. In the results obtained from Bountiful variety before irrigation, the connection was average (-0,4), while in all other varieties connections were found to be strong negative before and after irrigation. That is, the more relative humidity of air increased, the more water deficiency of cultivars decreased.

Contrary correlation connection was determined between water deficiency on the leaves of strawberry and water amount. In accordance with the results obtained from the field experiments before irrigation and after irrigation, negative connections were different in the varieties, that is, strong and average. Thus, the increase and decrease in water amount on the leaves influence contrarily on water deficiency.

It was also observed that there existed contrary correlation connection between water deficiency of the leaves of strawberry and soil moisture of experimental field. In the results obtained before and after irrigation, it was apparent that negative connections were different in varieties. Thus, the increase or decrease in soil moisture can cause to increase or decrease in water deficiency in the cultivars.

Water deficiency of strawberry cultivars has been presented in 6,7,8,9 figures.

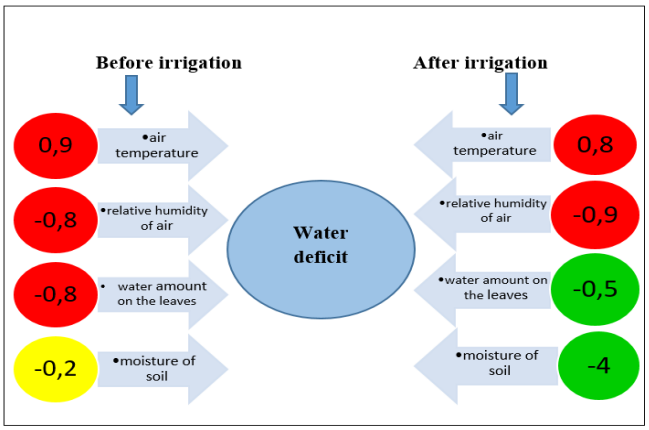

Figure 6: Uzbekistanskaya variety

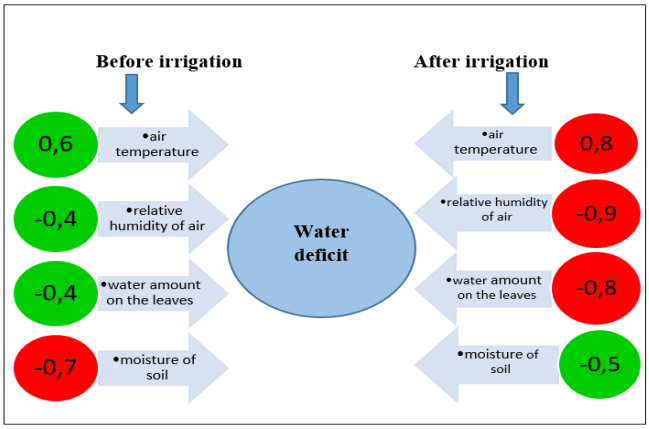

Figure 7: Bountiful variety

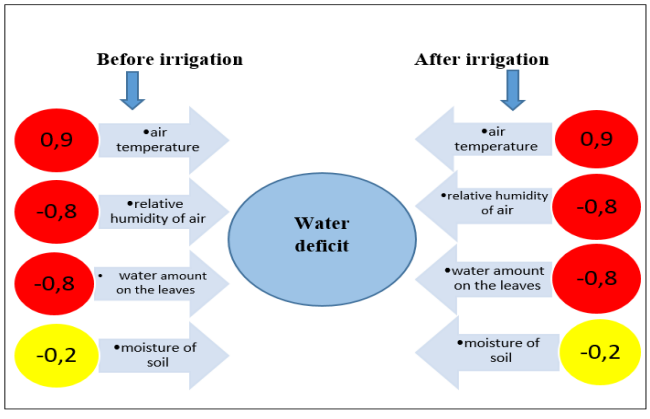

Figure 8: Preya variety

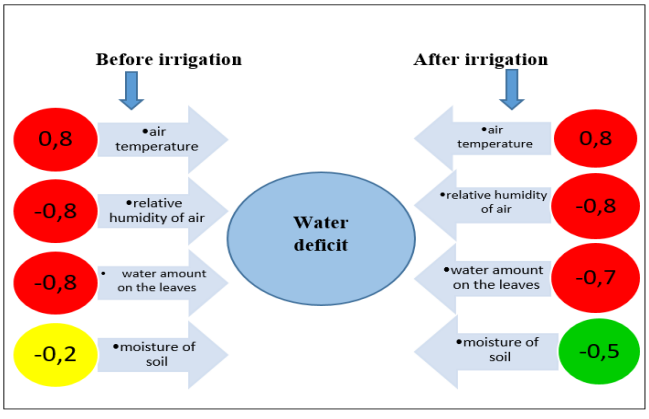

Figure 9: Voskhod variety

In 2017-2019 water amount on the leaves of golden currant cultivars was changeable during the vegetation and among the cultivars, and was found not to have sustainable indications.

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Drought-resistance of golden currant was also studied in the experiments. It was defined that water amount level on the leaves of golden currant cultivars which were selected for experiments, can change during vegetation depending on water amount in the soil and photoperiod, and these indications can vary depending on cultivars. When water amount of the leaves of golden currant cultivars was studied before irrigation in experimental field, the most water amount was observed Lyovushka and Podarok Ariadne varieties in all months (Figure-10).

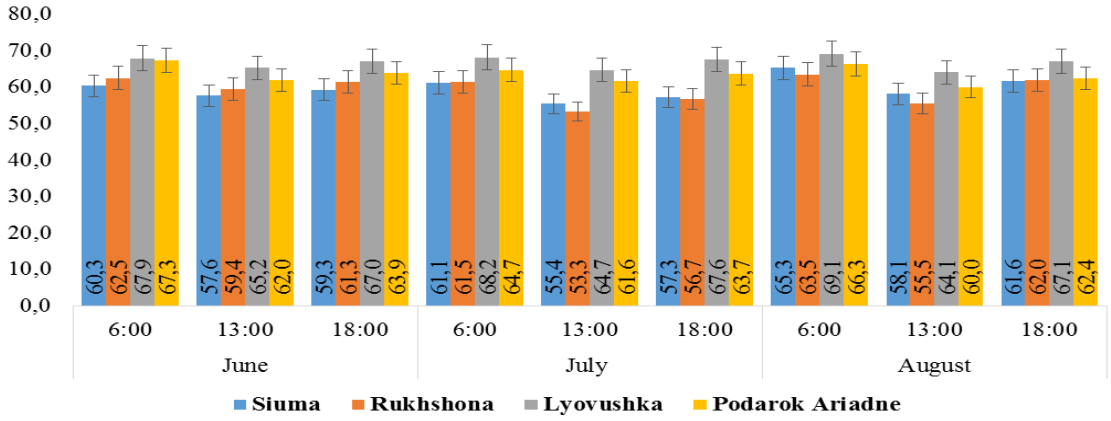

Figure 10: Water amount on the leaves of Golden currant cultivars (before irrigation), % (in 2017-2019)

Especially, the most maximal amount of water on the leaves was noted in the morning with the highest indications, in the second half of the day at 13^{00} it was contrary form, that is, decreased, by the evening water amount again increased. This phenomenon was determined in all tested cultivars, however, it should be noted that these indications varied among the cultivars. Water amount on the leaves remained between 62-75% in all period.

When irrigation procedures were conducted in experimental field of golden currant cultivars, the water amount of the leaves was determined to grow more than the indications without irrigation. Furthermore, it was determined that water amount on the leaves changed during the day being unsustainable. In the morning time water amount in all cultivars was found to be higher and by the second half of the day it decreased and again incrreased in the evening (figure-11).

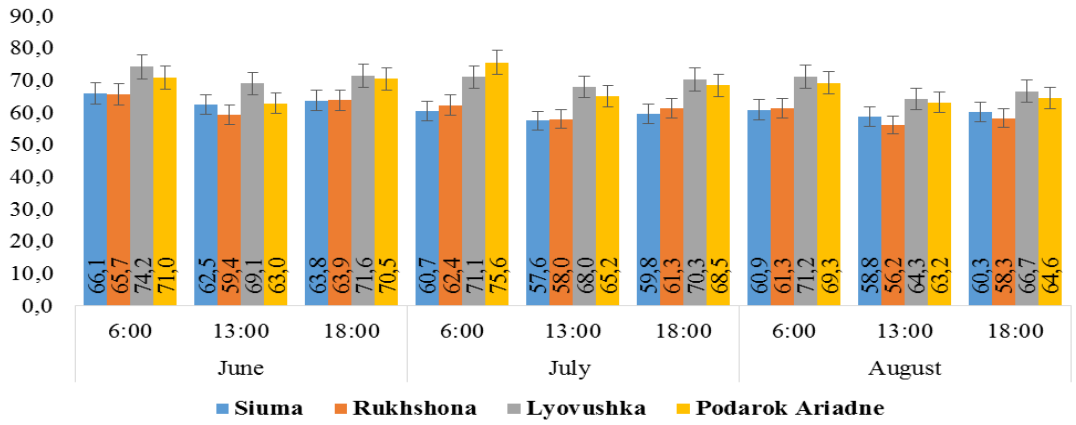

Figure 11: Water amount on the leaves of golden currant (after irrigation), % (in 2017-2019)

At the time of studying the water deficiency on the leaves of golden currant cultivars, the case was observed which was similar to the studying period of water amount on the leaves. Despite the soil moisture level before and

after irrigation, the change in water deficiency on the leaves, that is, the highest deficiency was noted at the daytime and the lowest one in the morning time. It was determined that according to the results of analysis obtained before irrigation the water diefiecincy of the leaves was 28,7% in June in Siuma control variety among the tested cultivars by the results taken at 13:00 o'clock, in July - 29,0% and in August - 31,9%, despite soil moisture of experimental field and photoperiod. The cultivars with the lowest water deficiency indication were Lyovushka and Podarok Ariadne varieties (figure-12).

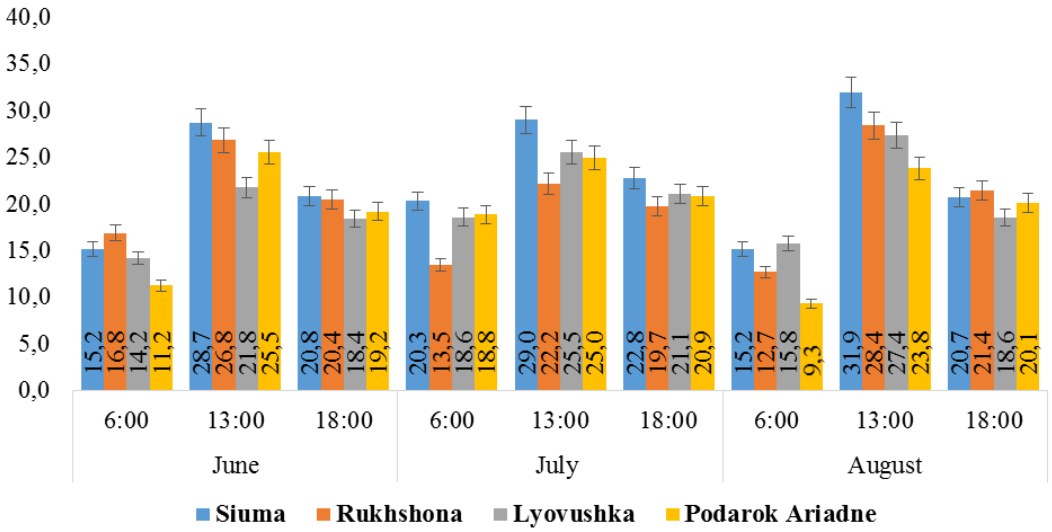

Figure 12: Water deficiency on the leaves of golden currant cultivars (before irrigation), % (in 2017-2019)

In the results taken after irrigation of experimental fields it was apparent that water deficiency in all cultivars was lower than the indications taken before irrigation. The change of water deficiency during the whole day was different: in the morning around 6:00 o'clock it was lower, at noon at 13:00 increased and by the evening again decreased. In July when the hot air temperature is of its peak, water deficiency was high at daytime around 13:00 o'clock in all cultivars. Particularly, Podarok Ariadne variety faced the highest water deficiency (40,6%) in July. While in Lyovushka variety water deficiency was a bit lower on the leaves in all months (figure-13).

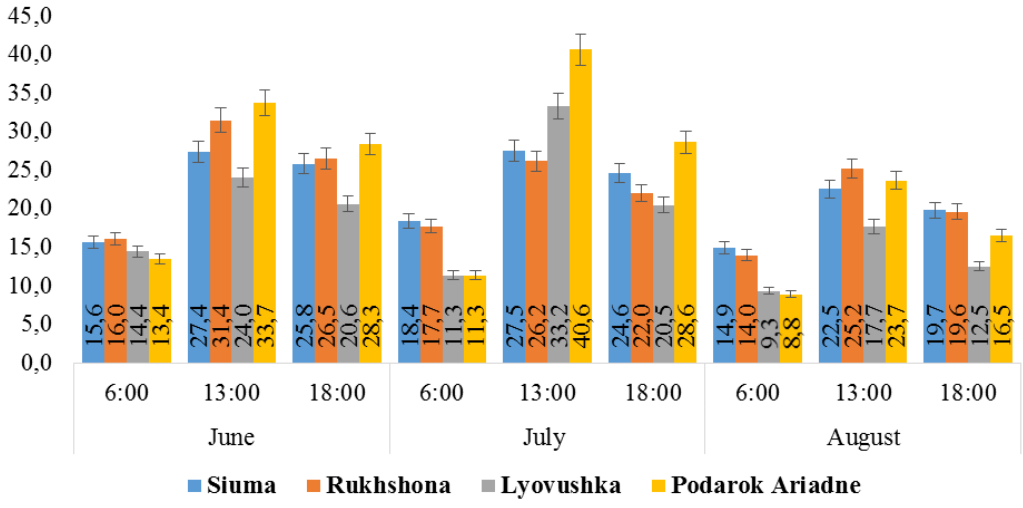

Figure 13: Water deficiency on the leaves of golden currant cultivars (after irrigation), % (in 2017-2019)

Moreover, according to the results of analysis on the leaves of golden currant cultivars, the correlation connection was evaluated between water deficiency and air temperature, relative humidity of air, water amount on he leaves and soil moisture.

It was determined that there was good correlation, that is, strong positive connection (between 0,7 and 0,9) between water deficiency of all cultivars of golden currant and air temperature. Considering this, it is clear that the more air temperature rises, the more water deficiency increases.

The correlation connection between water deficiency of golden currant cultivars and relative humidity of air was found to be contrary (strong negative). The connection in Siuma variety was the strongest negative (-1) in the results after irrigation. When relative humidity of air in the fields increases, water deficiency of the cultivars decreases accordingly.

Contrary correlation connection was also noted between water deficiency on the leaves of golden currant and water amount. In accordance with the results obtained before and after irrigation of the fields (negative) connections were in different degrees depending on cultivars. Thus, the increase or decrease of water amount on the leaves can influence contrarily on water deficiency.

There was contrary correlation connection between water deficiency on the leaves of golden currant and soil moisture of experimental field. By the results obtained before and after irrigation of the fields, negative connections varied in the cultivars. Only in Siuma variety connection (0) wasn't observed between water deficiency after irrigation and soil moisture. Thus, the increase or decrease in soil moisture can cause the increase or decrease in water deficiency on the leaves of cultivars. Water deficiency of golden currant cultivars has been presented in figures 14,15,16 and 17.

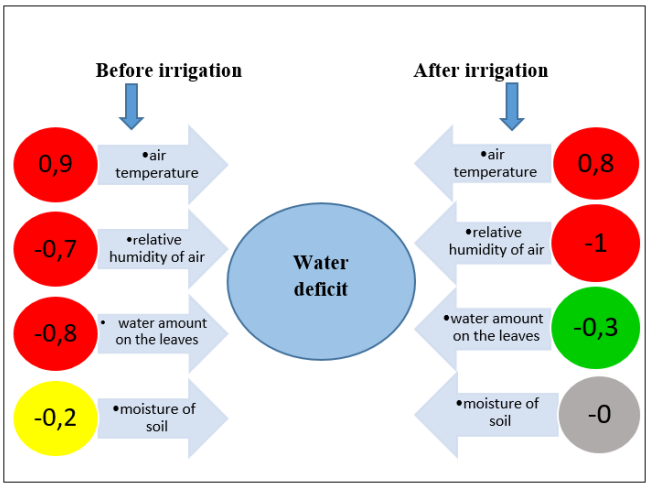

Figure 14: Siuma variety

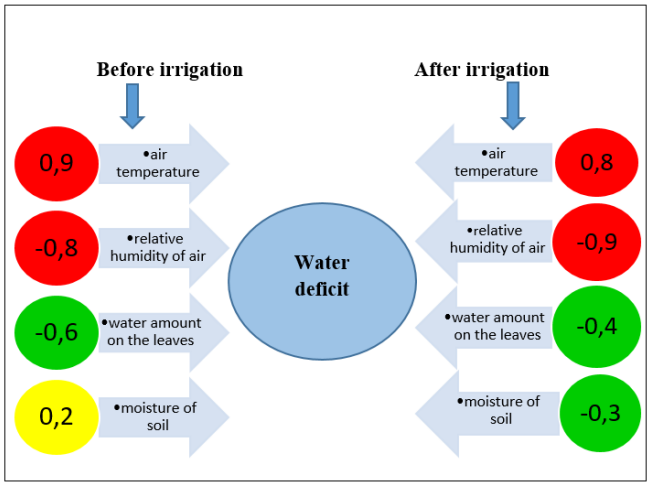

Figure15: Rukhshona variety

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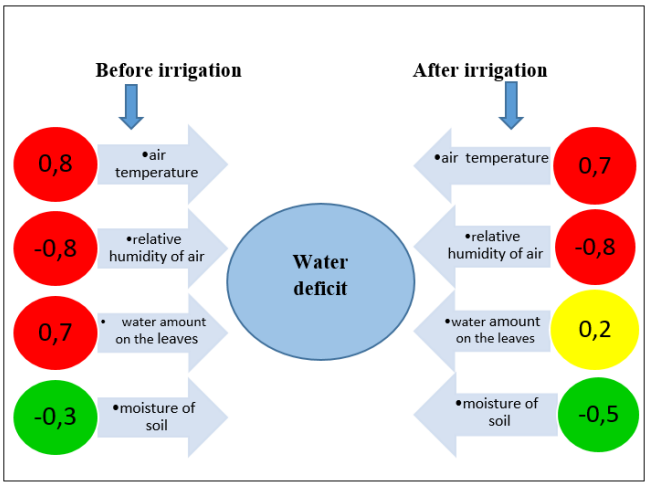

Figure 16: Lyovushka variety

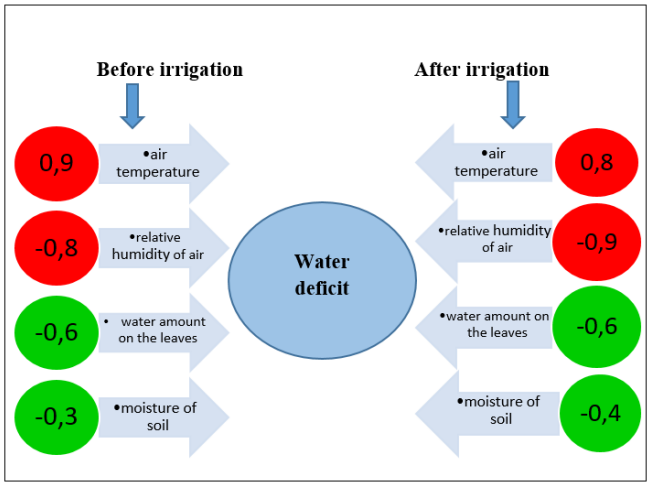

Figure 17: Podarok Ariadne variety

IV. CONCLUSION

The following mechanism was observed in the results of the study on drought-resistance of strawberry and golden currant cultivars:

1. In summer months the more air temperature increased, the more water amount decreased on the leaves, resulting in water deficiency rise and in August air temperature decreased following increasing of water amount on the leaves and decreasing of water deficiency. In July month water deficiency rose to the peak in all cultivars and water amount on the leaves was noted to decline to the lowest degree.
2. Due to low air temperature and its relative humidity at 6:00 morning, water deficiency was also lower accordingly, while at noon 13:00 o'clock air temperature was found to increase maximally and relative humidity of air decreased to minimal degree resulting in increase in water deficiency, by evening 18:00 the air temperature decreased and relative humidity of air increased a bit causing decline in water deficiency.

***The followings were determined under the study of drought-resistance of strawberry and golden currant cultivars*:**

1. Increase in air temperature allows an increase in water deficiency of plants.
2. Decrease in relative humidity of air also causes increase in water deficiency on the plants.
3. Decrease in water amount on the leaves of strawberry and golden currant cultivars causes increase of water deficiency.
4. Decrease in soil moisture of experimental fields where strawberry and golden currant where cultivars are sown, causes increase in water deficiency.

Consequently, it was determined that Bountiful and Preya varieties of strawberry, Lyovushka variety of golden currant were found to be the most resistant to drought among other cultivars.

In future these cultivars will be used effectively in breeding to creat drought-resistant varieties.

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