ANALYSIS OF CONDITIONS AND RESULTS OF THE RASPBERRY PRODUCTION IN ARILJE RASPBERRY-MOUNT[1]

Nataša Kljajić[2]

Abstract

Raspberry is the most important species of berry fruits, which achieves extremely high yields in the favourable agro-ecological conditions, along with the application of modern and adjusted agro-technique. It cultivates easily and simple; the production risk is significantly lower than regarding big fruits; it employs sufficient labour, especially regarding picking, while the financial resources invested in its products can be soon returned. In conditions of the current climate changes, the application of irrigation, limited to smaller areas in a private property on the territory of Arilje raspberry-mount, has provided the results in form of high and uniform yields of high-quality fruits, which can be easily sold on the market. In this manuscript conditions and results in the production of raspberry in Arilje-mount were first of all analysed, and then some of measures for the improvement of raspberry production were suggested, and finally there was made a recommendation for the introduction of renewable energy sources in the production. These positive experiences should be expanded to the territory of entire Serbia, by which can be affected to the improvement of situation in agriculture, as well as the entire economic situation.

Key words: *raspberry, climate, irrigation, production, renewable energy sources.*

Introduction

Fruit growing is one of the most profitable branches of agriculture. The natural conditions of Serbia, climate and land, are extremely favourable for fruit growing, and the advantage of our fruit growing reflects in the spatial and biological diversity and tradition in fruit growing. No

[1] This paper work is result of the project III – 46006 Sustainable agriculture and rural development in terms of the Republic of Serbia strategic goals realization within the Danube Region, finance by Ministry of Education, Science and Technological Development of the Republic of Serbia.

[2] Nataša Kljajić Ph.D. Research Associate, Institute of Agricultural Economics, Belgrade, Volgina street 15, 11060 Belgrade, e-mail: natasa_k@iep.bg.ac.rs

agricultural branch can bring that kind of profit like fruit growing, especially in hilly-mountain areas. On the other hand, there was made a great turning point in the new technologies introduction and the change of variety assortment structure, and this could be thanked to science, profession and manufacturers who were willing and ready to accept new, modern production technologies.

Orchards in the Republic of Serbia, with a total area of 163.310 ha in a total used agricultural land have the share of 4.7%, i.e. they make 6.2% of arable land (*Statistical Yearbook of the Republic of Serbia, 2015*). The greatest importance for our country's economy, within fruit production, has the production of berries (strawberry, raspberry, blackberry, blueberry, cranberry, currant and gooseberry), because there realizes around 250 million € of income from their export (http://www.novosti.rs/vesti/naslovna/ekonomija/aktuelno.239.html:578520-Srbija-na-prvom-mestu-u-svetu-po-proizvodnji-malina) and within berries, it is raspberry.

Raspberry *(Rubus idaeus L.)* is the most important species of berries. Raspberry fruits are attractive, very tasty, of extraordinary aroma, succulent, with great nutritive, dietary and technological value and this is why raspberry is very appreciated and saleable fruit, manifesting significant advantages in regard to other fruit species. It reproduces easily and starts to bear in the first or second year after planting, while it reaches full ripening in the third year. In favourable agro-ecological conditions, with the application of modern agrotechnics, raspberry achieves high yields. It returns the investments quickly and contributes to better utilisation of land in hilly-mountain areas. The investments in plantations are relatively high, but the invested funds return quickly. It grows easily and simple, the production risk is significantly lower than regarding big fruits; it employs a lot of manpower, especially when harvesting.

In recent years, raspberry has become the most significant Serbian export product, while Serbia has become famous in Europe by raspberries as the national products, which has persevered the competition on a choosy west market. Over 90% of produced raspberry is frozen and exported, while the rest is sold as a fresh or processed in other products. Around 25% of the world production of raspberry comes from Serbia. It exports by an average price of 1,4-1,5 €, mostly frozen. If raspberry would export as fresh, in a „map“ package, raspberry could sell even 2-3 times more expensive. Small quantities export as fresh and as concentrates. Fresh

raspberry is avoided to be exported as fresh, because it is highly perishable. In past years, the most attractive export products are frozen raspberry in the form of rolend, semolina and block (*Kljajić N., 2014*).

Besides numerous positive characteristics, some of the raspberry weaknesses are: high sensitivity of fruits, weak permanence, poor transportability, gathering of fruits is done along with a high participation of manpower, etc.

Specific economic significance of raspberry is determined by the following factors: high and diverse use value of a fruit; relatively high rate of return in favourable agro-ecological conditions; high merchantability of a product; additional employment of manpower and indirect impact to an overall social-economic development; raspberry as a honey plant, etc. *(Petrović and Milošević, 2002).*

In past years, the production and yields of raspberry per area unit in Serbia vary significantly due to the direct and indirect influential factors, such as: - inappropriate land for plantations; - poor health and quality of planting material; – inadequate application of agro and pomo-technical measures, etc.

Among the mentioned factors, climate has also increasing and more expressed impact to the height of yields, and it manifests through frequent and longer droughts, caused by the increase in air temperature and the decrease in precipitations, resulting a need for irrigation in the process of raspberry production.

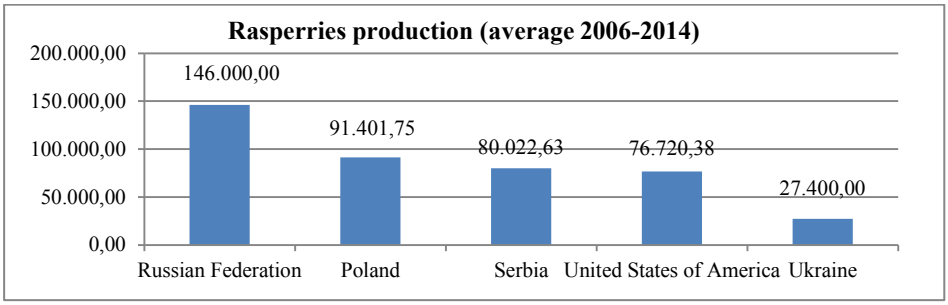
Seasonal change of the climatic parameters in past years has become a limiting parameter for intensifying agricultural production and especially the disposition and amounts of precipitations during the vegetative period. The only long-term form of the fight against drought is the introduction of irrigation in agricultural practice, as the regular and mandatory measures. The application of irrigation, limited to smaller areas in private ownership on Arilje raspberry-mount area, has given the results in form of high and uniform yields of high quality fruits, which are easy to sell on the market. These positive experiences should expand to the territory of entire Serbia, by which could affect to the improvement of situation in agriculture, as well as to the entire economic situation (Kljajić N., et all, 2013).

The production of raspberry in the Republic of Serbia

The production of raspberry worldwide is realised on relatively small areas regardless that there is much more space for its cultivation (Kljajić N., et all, 2013).

In an analysed period of raspberry production in the world (2006-2014), described in the graph 1, we can see that Serbia is among leading manufacturers. It takes a third place, right after the Russian Federation and Poland.

Graph. 1. *Average production of raspberry in the world in time period 2006-2014*



Source: http://faostat3.fao.org/browse/Q/QC/E

The production of raspberry in the Republic of Serbia in the period 2006-2016 was shown in *Table 1*. An average area under raspberry-yards for the studied period amounts 13,579 ha, and average yield is 76,807 t, or in average 5.7 t/ha of manufactured raspberry.

Table 1. *The production of raspberry in the Republic of Serbia in time period 2006-2016*

Year of research	Republic of Serbia		
	Areas under raspberry plantations (ha)	Total yield (t)	Yield (t/ha)
2006	15,024	79,680	5.3
2007	14,496	76,991	5.3
2008	14,680	84,299	5.7
2009	14,957	86,961	5.8
2010	15,174	83,870	5.5
2011	15,354	89,602	5.8
2012	11,996	70,320	5.9
2013	12,024	68,458	5.7
2014	11,040	61,715	5.6
2015	11,041	66,176	6.0
Average	13,578.6	76,807.2	5.7

Source: *Statistical Office of the Republic of Serbia, Statistical Yearbook of RS, 2007-2016*

Raspberries export as frozen or as manufactured products for concentrates and juices. In the year 2015 Serbia was earned 260 million USD from raspberry, which had put it in position of the greatest raspberry exporter into the European Union. The members of the Serbian Business Association of Cold Storages realize from 60% to 70% of domestic export of raspberry, and almost all cold storages – the members of the association have HACCP standards and all other standards which the world market has required (https://adavinic.wordpress.com/2016/04/26/poslovno-udruzenje-hladnjaca-srbije-i-svetska-organizacija-iro-organizuju-svetski-susret-malinara/).

The largest amount of frozen raspberry was exporting in Germany, then in France, Belgium, USA, Sweden, Great Britain, the Netherlands in 2012, 2013 and 2014 (*Table 2*).

Table 2. *Export of raspberry by countries in time period 2012-2014*

	Quantity, t			Value, thousand USD		
	2012	**2013**	**2014**	**2012**	**2013**	**2014**
Raspberry frozen, sugarless	64,417	61,417	73,253	135,648	187,358	236,518
Germany	24,296	22,447	24,122	50,500	68,579	78,930
France	16,404	16,215	17,058	32,256	43,781	51,276
Belgium	7,199	7,087	7,276	16,872	24,412	25,045
USA	1,260	1,304	3,554	3,138	4,938	12,733
Sweden	1,954	2,680	3,420	5,776	9,122	12,280
Great Britain	2,386	1,734	2,296	4,840	5,924	7,124
The Netherlands	1,429	1,019	2,172	3,087	2,871	6,877
Other countries	9,340	8,931	13,355	19,179	27,731	42,253

Source: *Statistical Office of the Republic of Serbia, 2015*

The area of Arilje raspberry-mount, with its production centre Arilje, belongs to Zlatibor District, and it is located between the river basins of the rivers Moravica, Veliki Rzav and Mali Rzav. Agriculture dominates in the structure of municipal national income (with 41%) thanks to, first of all, favourable natural conditions for its development, as well as the acquired tradition in production.

Thanks to the production of raspberry and simultaneously synchronized development of other economic branches, this initially economically underdeveloped area has become highly-developed for our conditions, with numerous local cold storages. Foreign exchange assets gained by the export of raspberry, used for the import of the latest equipment for Arilje production, were indirectly allocated to necessary working capital for the primary production needs and the processing of raspberry, along with very important provided support of factory workforce in the production of raspberry in the harvest „tips" through the collective vacations (which can serve as example to other municipalities).

Areas under raspberry in Arilje municipality are 1,226.05 ha (census of agriculture, the year 2012), in which there manufacture annually in average 15,000 t (13,500-16,500 t). Around 20,000 t of raspberry fruits are frozen, processed and exported in cold storages from the municipal territory. Raspberry grows in the whole municipal territory in over 95% in family holdings, on average plots of around 0.3 ha. As a working intensive crop, it has a great influence on additional employment (http://arilje.org.rs/privreda/poljoprivreda.html/09.11.2016./).

The production of raspberry in Arilje makes 19.5% of total raspberry production in the Republic of Serbia (areas under raspberry in the Zlatibor District are 3,893 ha, and in the region of Sumadija and West Serbia 10,513 ha, also according to data of Census of Agriculture, 2012).

The yields of raspberry vary from year to year depending on variety, health condition and age of plantation, ecological conditions and agro-technique, which is normal regarding that the high utilization of the raspberry genetic potential can be achieved only if all production factors are in the harmonious-optimal relationship.

Therefore, despite of a high technology of the raspberry espalier cultivation and a genotype of well selected variety (Willamette), the yields of fresh fruits in Arilje-mount vary in the range from 7.5 to 11.8 t/ha in conditions of natural water regime, i.e. without irrigation, although its genetic potential reaches even 52 tons per hectare (Milivojević J., and associates, 2005).

Drought, which is present almost every year with longer or shorter duration, jeopardizes seriously the production of raspberry, especially in „the critical period" (phenophase from the raspberry flowering phase to picking season in

June and July), when raspberry needs water the most. Irrigation then becomes not only inevitable, but also its use becomes more effective.

On sloping terrain of Arilje-mount, on which most of the existing raspberry-yards are located, after all as in the whole Serbia, raspberry mostly can irrigate by local soil wetting using drop irrigation. Such irrigation system is considered as the most perfect technical-technological solution in the cultivation of raspberry in terms of irrigation.

The climatic water balance during the raspberry vegetative period in Arilje-mount was determined in this manuscript according to climatic specificities, which were analysed through the mean monthly values of climate parameters for the period from 2006 to 2015. Data refer to the weather station „Pozega".

Thereby, evapotranspiration is determined by a FAO *Penman-Monteith* method, by the following relation:

$$ET_0 = \frac{0.408 \cdot \Delta \cdot (R_n - G) + \gamma \cdot \frac{900}{T + 273} \cdot u_2 \cdot (e_s - e_a)}{\Delta + \gamma \cdot (1 + 0.34 \cdot u_2)}$$

ETo–reference evaporation (mm/day); **Rn**–net radiation on crops canopy (MJ/m^{2}xday); **G**–energy consumed for soil heating (MJ/m^{2}xday); **T**–the mean monthly air temperature on 2 meters of height (^{o}C); $\mathbf{u_2}$–wind speed measured on 2 meters of height (m/s); $\mathbf{e_s}$–saturated steam tension (kPa); $\mathbf{e_a}$–real steam tension (kPa); $\mathbf{e_s}$-$\mathbf{e_a}$–deficit of steam tension (kPa); **Δ**–curve inclination of steam tension (kPa/^{o}C); **γ**–psychometric constant (kPa/^{o}C).

The amount of effective precipitations during the productive part of vegetative period of raspberry (April-September), which refers to a part of total precipitations which raspberry uses effectively through its root system, is determined by FAO method (*FAO Bullten d'irrigation et de drainage (1984): Precipitation eficale. Rome. p.p. 1-40*).

Rapberry yields in terms of the natural water regime, i.e. without irrigation, were taken over from the Republic Statistical Office, while in terms of irrigation, from the experimental fields located in Arilje raspberry-mount, on which the research was conducted under the auspices of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

Research results

Necessary amounts of water for the successful cultivation of raspberry are variable, not only from year to year, but also during the same growing season.

They depend on the series of factors in the soil-plant-atmosphere system, which could be thoroughly studied in the determination of the irrigation order. In the first instance, they depend on the climatic-meteorological features of an area in which grows raspberry; on climatic conditions; and finally on the raspberry biological features.

It means that raspberry needs for water are of local character and depend on a complex impact of the environmental conditions and biological features of a plant (Sredojević Z. et all, 2013). Therefore the determination of an optimal irrigation order of areas under raspberry, which means the frequency norms and watering by the specific periods of time, is a very complex process and requires a multi-year study.

Two basic numerous climate characteristics, by which express the impact of energy and aero-dynamic condition of atmosphere ground layer to the amount of energy which land under the raspberry plantations receive and indulge in the atmosphere to the amount of water that enters from the atmosphere into the soil and evaporates from soil to atmosphere, are: - reference potential evapotranspiration ETo (mm/day); i –effective precipitations Pe (mm).

Reference potential evapotranspiration expresses the energy and aero-dynamic condition of atmosphere ground layer, which poses a law that a certain amount of water delivers from land surface by evaporation and transpiration through herbal cover stoma (raspberry), which would saturate the air to a maximum possible level in a form of aqueous vapour.

Hypothetically, it is equal to evaporation from land, covered by thick grass in full rise, of uniform height 0.12 meters, fixed surface resistance of 70 s/m and albedo of 0.23. The fixed surface resistance essentially means a medium dry soil surface watered by a weekly watering number (*Allen et all. 1998*), which volume is shown in Table 4.

Table 3. *Climate parameters in Arilje rasberry-mount (2006-2015)*

Months	Years of research									
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
	Maximum monthly air temperatures(Tmax. °C)									
April	17.7	20.2	17.9	19.9	17.7	18.2	18.7	20.1	17.0	17.5
May	22.5	23.3	23.2	24.5	22.1	21.6	21.4	23.4	20.8	23.4
June	24.8	27.8	26.8	25.2	25.2	26.0	29.2	24.9	25.0	25.4
July	27.8	31.4	27.8	28.2	27.9	28.2	31.6	28.5	27.2	30.9
August	25.7	29.7	28.9	27.9	28.1	30.2	32.3	30.0	27.1	30.7
September	23.0	20.4	20.8	24.5	22.2	27.8	27.6	22.5	21.1	24.8
	Minimum monthly air temperatures(Tmin. °C)									
April	5.9	2.0	5.4	4.4	5.1	4.0	3.5	4.3	5.7	2.7
May	8.5	10.8	8.8	9.6	9.1	9.1	8.2	9.6	9.0	10.0
June	12.5	14.1	14.2	12.8	13.7	12.4	12.8	13.2	12.4	12.1
July	14.0	12.6	13.7	14.3	15.2	13.9	14.6	12.9	15.1	14.5
August	13.5	14.3	12.8	14.5	14.8	12.8	11.5	13.5	15.1	14.4
September	11.1	8.4	8.9	10.6	10.1	10.7	9.5	8.5	12.5	12.0
	Mean monthly air temperatures (Tsr. °C)									
April	11.3	10.9	11.0	11.8	11.0	10.6	10.7	12.0	10.6	10.0
May	14.7	16.6	15.4	16.7	15.1	14.3	14.5	16.0	14.1	16.5
June	18.2	20.2	19.7	18.4	19.2	19.1	21.1	18.5	18.1	18.3
July	20.1	21.6	20.3	20.6	21.0	20.6	22.9	20.3	20.2	22.4
August	18.7	21.1	20.0	20.3	20.6	20.7	21.4	21.0	19.7	21.6
September	15.9	13.1	13.9	16.2	15.1	17.8	17.5	14.4	15.5	17.6
	Monthly sun exposure values (n. h)									
April	115.5	264.4	114.3	176.2	137.9	178.0	160.7	207.9	100.7	192.7
May	202.8	193.6	211.7	210.1	155.9	186.3	183.0	199.9	171.2	191.8
June	184.6	232.0	216.5	198.1	182.0	248.2	315.6	203.1	220.5	245.8
July	232.2	346.7	235.4	272.7	235.4	269.2	302.1	309.9	240.8	313.2
August	185.5	235.1	281.3	220.2	240.7	293.3	333.3	270.1	221.7	252.0
September	155.7	137.5	141.3	168.2	141.3	232.7	221.0	171.2	91.0	165.7
	Mean monthly values of relative air humidity (RH. %)									
April	76	70	77	74	80	73	76	72	83	70
May	75	79	78	75	80	81	80	76	81	75
June	77	77	79	78	82	74	71	78	80	78
July	78	67	76	77	81	75	69	73	80	71
August	81	74	74	80	80	72	62	70	82	74
September	84	83	80	81	82	75	70	80	90	78
	Mean monthly values of wind speed measured 2m above land surface (V.m/s)									
April	0.7	0.6	0.7	0.7	0.9	1.3	1.2	1.0	0.9	1.3
May	0.9	0.6	0.4	0.6	1.0	1.0	1.0	1.1	1.2	1.0
Jun	0.4	0.6	0.4	0.6	0.8	1.2	1.1	1.0	1.0	1.1
July	0.4	0.7	0.6	0.5	0.5	1.0	1.0	1.0	1.0	1.0
August	0.5	0.6	0.5	0.3	0.5	0.8	0.9	1.1	1.0	1.0
September	0.4	0.3	0.4	0.2	0.5	0.9	1.0	0.9	0.8	0.9
	Monthly sums of total precipitations (Puk. mm) (Puk=Pe)									
April	73.9	22.2	52.2	22.5	58.8	28.7	64.9	28.5	169.1	52.1
May	49.3	98.6	96.6	25.3	66.5	88.6	106.8	100.9	188.7	49.8
June	134.6	46.3	54.4	169.4	99.7	33.9	50.3	91.4	109.5	83.4
July	107.7	37.3	72.2	70.1	83.5	71.0	52.3	21.6	103.4	11.1
August	120.5	41.9	11.6	61.9	38.5	8.1	1.8	36.2	98.6	41.5
September	39.9	110.1	77.6	17.5	48.3	43.4	10.7	71.6	169.1	66.2
Sum=Pe	525.9	356.4	364.6	366.7	395.3	273.7	286.8	350.2	838.4	304.1

Source: *Meteorological yearbooks. 2006-2015. Republic Hydromeorological Service.*

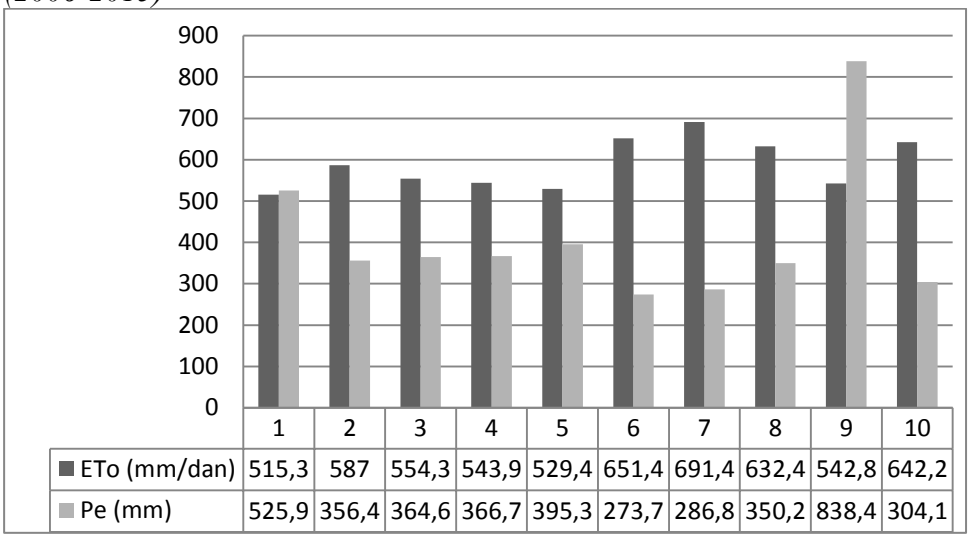
Table 4. *Mid vegetation values of evapotranspiration in Arilje raspberry-mount (2006-2015)*

Months	Years									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
April	2.01	2.44	2.27	2.15	2.24	2.41	2.32	2.52	1.77	2.48
May	2.87	2.57	2.72	2.85	2.50	2.99	2.99	3.29	2.92	3.14
June	3.08	3.54	3.29	3.34	3.10	4.09	4.73	3.67	3.69	4.00
July	3.52	4.62	3.78	3.81	3.60	4.27	4.83	4.54	3.94	4.74
August	3.09	3.49	3.61	3.22	3.43	4.07	4.63	4.13	3.48	4.04
Sept.	2.29	2.55	2.47	2.43	2.46	3.05	3.13	2.53	1.95	2.61
Total	515.3	586.9	554.3	543.9	529.4	651.3	691.3	632.4	542.8	642.2

The vegetation evapotranspiration sum in Arilje raspberry-mount ranges from 515 to 691 mm and varies from 1.77 mm/day (minimum) to 4.83 mm/day (maximum). Its highest values are in June and July, when there is instantaneous the highest water deficit in soil and the greatest demand of raspberry for water.

The effective precipitations are part of total precipitations used by raspberry, and for this paper's needs, by the effective precipitations (*Table1, Graph 2*) are considered all precipitations that fell on land surface, regardless to their daily sums amounts, because in order small amounts of rain to fall, it is necessary to get cloudy, by which reduces insolation and also air temperature. The relative air humidity reduces by passing raindrops through the atmosphere and by their evaporation, and all that leads to the reduction of total water amount needed for irrigation *(Milivojević, 1984)*. Their total sums in raspberry vegetation period range from 273.7-838.4 mm. and they are lesser (in most of years of the research) in regard to a total water inflow from rain (*Table 1*) for 25.33 to 58.52 %. The biggest difference was in 2012, which was known as extremely dry year, while the years 2010, 2006 and 2014, characteristic by the increased precipitations (2014, floods) were not taken into consideration because precipitations were surpassing evapotranspiration.
It is clear that in the productive part (vegetation period) of raspberry (April-September), precipitations do not provide raspberry with sufficient amount of water, by comparing the inflow of water by the effective precipitation (Pe. mm) and the outflow of water by evapotranspiration (ETo. mm/day) (*Graph 2*).

Graph. 2. *Histogram of climati–water deficit in Arilje raspberry-mount (2006-2015)*



	1	2	3	4	5	6	7	8	9	10
ETo (mm/dan)	515,3	587	554,3	543,9	529,4	651,4	691,4	632,4	542,8	642,2
Pe (mm)	525,9	356,4	364,6	366,7	395,3	273,7	286,8	350,2	838,4	304,1

It means that high yields of raspberry, water deficit of 134.13-404.55 mm, should be covered by irrigation. Natural water regime of land is corrected by this intervention and leads over from the group of natural into the group of anthropogenic water regimes of an irrigation type, to which raspberry reacts by significant increase in yields, as it was determined in multi-year experiments conducted in Arilje raspberry-mount.

The use of irrigation in the raspberry cultivation systems is of great importance, while there provides easily-accessible water (which misses during the growing season in case of reduced precipitations) by its use. The use of irrigation is caused by many factors, as the climatic, land and orographic conditions, the needs of raspberry for water by the specific phenophases of its vegetative cycle, the possibility to supply a large amount of water of adequate quality, etc.

The drop irrigation systems use intensively in raspberry-yards in past years, and they have the negligible water losses compared to the maximum effects achieved by its use (Gajić B. et all, 2013). Water disposes in drops under small pressure and moistens soil nearby every plant, slowly, only several litres per hour (1, 2, 3 l/h) through droppers, disposed on pipes laterally (laterals). It is done until the optimal soil moisture in an active rhizosphere layer is not provided.

Soil features. On the territory of Arilje municipality can be found diverse types and sub-types of soils, extremely heterogeneous by their many characteristics (rootstock plantation, age, the depth of the active rhizosphere layer, mechanic and chemical characteristics, water and air regulations, etc.), which has the controlling influence on the ways of their use. First four classes soils participate in total areas with 3,369 ha, i.e. only 16.74%.

All soils on this territory can be divided in four large groups:

- *Soil of river valley, dry river and lake terraces and basins* – they occupy around 10% of agricultural areas and have a great importance for agricultural production due to favourable configuration, deep and fertile arable layer and the possibility to irrigate,
- *Newly-created soils in the first zone of the delluvial water accumulation* – they occupy around 70% of areas. Those are mostly underdeveloped land with different production capacity. Besides dominating meadows, pastures and forests, these soils are favourable for the cultivation of raspberries but also other berries, then plums, apples and some other types of vegetables (potato and others),
- *Skeletal soils above and below the first zone of delluvial water accumulation* – they were created mainly below degraded forests and pastures by erosion. They occupy around 15% of areas and mainly are in hilly-mountain zones,
- *Upland dark fertile soil* on limestone substratum in the grass vegetation zone, on the mountainous highlands – they occupy less than 5% of areas and are located in south-west part of the municipality. They have different production capacity and use for growing potato, or as pastures, meadows and bushes (Kljajić, 2012).

Hydrographic features. On the territory of Arilje municipality there are three major watercourses. These are the rivers Moravica, Veliki Rzav and Mali Rzav and more secondary watercourses and numerous springs. Thus, this area is rich with water potential and it has extremely favourable conditions for irrigation (Kljajić N., 2012).

Measures and recommendations for the improvement of raspberry production

Some of the measures, practical for the improvement of fruit growing and raspberry growing in Serbia, are:

1. Optimum plant density, specific for every combination of varieties/rootstocks aiming to increase productivity per area unit,
2. Setting up the anti-hail networks which, in addition to the protection of hail, also prevent the phenomenon of fruit scorches from high temperatures,
3. Selection of good assortment structure,
4. Biological control of fertility should be a base, not only for the determination of pruning intensity, but also for planning yields, packaging and protection agents,
5. Fruit nutrition must be adjusted to the Integral production concept requirements. The program of fruit trees fertilization must be based on the results of a land and foliar analysis, the needs of varieties, characteristics of the land maintain system, fruit growing system and a planned yield,
6. Indispensable use of irrigation without which there is no modern intensive production of fruits,
7. Introduction of new technologies of storing and packaging fruits and modern mechanization in fruit growing,
8. Association of manufacturers and creating a brand.

It is necessary to accept it in the harsh market conditions of the modern production technology, and especially the quality standards (GlobalGAP, Integral production) (http://www.ains.rs/predavanja/AINS-VOCARSTVO%20SANSA%20POLJOPRIVREDE.htm).

Raspberry, among other features, has also the epithet of ecological, i.e. „heathy safe food“, and therefore export could increase, along with the adequate marketing measures, because there is significant and stable export demand.

In terms when it is necessary to provide a favourable environment for faster economic and agricultural recovery, it is inevitable to elaborate a developmental concept of further improvement of fruit production. It is necessary to elaborate developmental programs on the stable marketing basics in accordance to available ecological conditions and the requirements of a modern domestic and foreign market http://www.novosti.rs/vesti/naslovna/ekonomija/aktuelno.239.html:601982-Malinjaci-najvece-fabrike-u-Srbiji).

Use of the renewable energy sources in the process of production. Renewable energy sources

When we talk about the climatic changes today, we think first of all on floods, extreme drought, wild-fires, peneplain, etc. since the beginning of the 20th Century, which have occurred as a result of an anthropogenic influence. All these phenomena are the results of global warming, which have occurred owing to the increased greenhouse effects.

The effects, or to say the consequences of global warming are multiple: more frequent and longer draughts, frequent floods, more frequent occurrences of severe hurricanes and storms, reduced amount of available fresh water, large disturbances in different eco-systems due to their "displacement" to north, when some species will be exterminated, infectious diseases will spread to north (for example, malaria), disturbances in food chains, disturbances in life cycles and phenophases, so we can expect that some plants bloom earlier than their pollinators appear, etc.

The most important mechanisms for the fight against climate changes and somehow the mainstay of energy independence in the future are the renewable energy sources regarding that they reduce dependence from unreliable and unstable fossil fuels markets, especially oil and gas.
Renewable energy sources (RES) comprise sun energy, water energy (hydro energy), air energy, geo-thermal energy, solid biomass, biogas, biodiesel and bio-ethanol. Unlike the non-renewable energy sources which have occurred in the tens of millions of years long process and which exhaust pretty fast (reserves are estimated to tens and hundreds of years), the renewable energy sources have constantly cyclically renewed, and they have been consumed at a rate that is less than the speed of their creation in nature (Kljajić N. et all, 2016).

Agriculture is a significant consumer of fossil fuels, which exploitation degrades land and water, while combustion releases gases with the greenhouse effect. The prices of agricultural products are highly dependent and sensitive on the fuel prices trends. For these reasons, using energy from the renewable sources becomes a very important issue for the future of the world food production. The use of energy from the renewable energy sources requires minimum engagement of limited land and water resources and they don't distort their ecological status.

The Republic of Serbia disposes with the renewable energy sources of sun, water, wind energy, as well as geothermal and biomass energy.

Some of the implemented researches in our country have determined the possibilities of efficient substitution of fossil fuels by electrical energy from renewable sources, mostly from sun and wind energy, in numerous activities which realize in the modern, multifunctional agriculture: for starting the pumps for irrigation, drying cereals, oleaginous plants and fruits in silo and driers, in the production of artificial fertilizers and pesticides, in greenhouse production and fishery and especially in organic production, pasture cattle breeding and agro-eco and eco-organic tourism, in holdings in areas with a high natural value and underdeveloped energy infrastructure, where the *solar systems* has an advantage.

However, this technology for some time requires subsidies to be widely adopted by farmers. Preconditions of this type of investments in agricultural sector, besides the financial resources, informing and the education of users, are the activities which usually aren't available to dominantly represented small and medium holdings, especially to those in remote areas, so the agricultural advisory services and the association of farmers and water users play an important role in this area.

Nowadays, the motor pumps and aggregates on petrol and diesel drive mainly use for the needs of irrigation in agriculture in family agricultural holdings in the Republic of Serbia.

For the purposes in agriculture use mostly the *stationary photovoltaic solar systems*, which are set on well sunny locations and nearby an agricultural area, i.e. gardens, arable plots and greenhouses/plastic foil houses, etc.

Windmills can also be used for irrigation, but mainly in Banat and areas with the air flow throughout the year.

As for the stationary photo-voltaic solar systems, they have shown as very efficient for irrigation, but also have a serious flaw that they can be used only in places where they are set and cannot be moved to other locations. In the Republic of Serbia, the family agricultural holdings (the highest percentage) have arable land mostly distributed, sometimes even several kilometres away one from another. In this respect, the stationary solar systems are not the economical solutions for this category of agricultural manufacturers, since they don't satisfy their needs completely in all locations. From this reason,

the agricultural manufacturers prefer to opt for purchasing the motor aggregates for irrigation than to invest in the solar systems for irrigation.
The solution for the above mentioned problem could be so called portable (mobile) solar systems for the production of energy. They have the advantage in a fact that they can be relatively easily and quickly moved from place to place without any special preparatory activities in the field. In that sense, these devices provide much more freedom and flexibility for their use in agriculture (*techno-economic aspects of the renewable energy sources use and the use of mobile robotize d solar electro-generators in agriculture. The study, Project of the Ministry of Agriculture and the Environment Protection of the Republic of Serbia, Institute of Agricultural Economics, 2015)* and they are good for a recommendation to use also for the raspberry irrigation.

Incentives of the Republic of Serbia for agricultural production

Registered agricultural holdings which are engaged in plant production can count on various incentives by the state. Accordingly, for the fruit growing sector and raspberry growing as well, in the year 2016 were planned the following incentives and were analysed according to the program activities[3]:

1. *Direct payments* which comprise:
    a) Basic incentives for plant production in amount of 2,000 RSD/ha,
    b) Recourses for fertilizers in amount of 2,000 RSD/ha,
    c) Recourse for the storage costs in public warehouses in amount of 40% of the storage costs;

2. *Measures of rural development* [4]:
    a) Stimulating new perennial plantations of fruit trees, grapevine and hop in amount of 150,000.000 RSD,
    b) Support for the improvement of primary agricultural production in amount of 514,100.000 RSD,
    c) Purchasing equipment in the dairy sector, the sectors of fruits,

[3] Decree on incentives distribution in agriculture and rural development in the year 2016, Official Gazette of RS, no. 8/16

[4] Recourses for the insurance premium for crops, fruits, perennial crops, nursery beds and animals reimburse in maximum amounts of 40% of paid insurance premium, i.e. in maximum amount of 45% of the paid insurance premium in areas with difficult working conditions in agriculture. For other analysed measures of rural development the incentives are paid in maximum amount of 40% of value, i.e. in maximum amount of 55% of a value in areas with difficult working conditions in agriculture.

vegetables and grape in amount of 90,000.000 RSD,
d) Recourses for the insurance premium for crops, fruits, perennial plantations, nursery beds and animals in amount of 450,000.000 RSD,
e) Incentives for organic production in amount of 92,000.000 RSD,
f) Incentives for the preservation of plant genetic resources in amount of 5,000.000 RSD;

3. *Credit support to fruit production* [5] – Loan fund which are granted to the registered agricultural holdings, entrepreneurs and legal entities which are engaged in fruit production. The state role reflects in subsidizing a part of interest which is charged on the loan. The loan repayment period is 1-3 years with a grace period of 1 year, interest rate is 6%, and the loan is granted and paid in RSD. Agricultural manufacturers which are engaged in fruit production can use a granted amount of loan if they purchase: planting material, all types of mineral fertilizers and plant protection agents;

4. *Special incentives*, and first of all the incentives for the production of planting material and certification and clonal selection in amount of 22,650.000 RSD;

5. *Support program to the private sector for fruits and berries in south Serbia* plans the total financial resources in amount of 110,001.000 RSD, of which 66,000.000 RSD of budgetary funds and 44,001.000 RSD of the government of the Kingdom of Denmark donations for the program implementation.

The mentioned incentives are paid from the budget of Ministry of Agriculture and the Environmental Protection through the Directorate for Agrarian Payments. The exception is resources meant for the credit support which pays off through the Fund for Stimulation of Agricultural Production Development in the Republic of Serbia.

Conclusion

Nature endowed the Arilje area with fertile land, clear mountain springs, streams and rivers, and the favourable microclimatic potential for

[5] Rulebook on conditions and a way of accomplishing the right to credit support, Official Gazette of RS, no. 30/14, 87/14 and 25/16.

intensive agricultural production in the field of fruit growing. The production of raspberry is related to this area the most, because this environment fits in all to raspberry. The climatic and land conditions are that favourable so they can provide the successful production of raspberry, along with the use of modern technology of growing and adequate agro-technical and pomo-technical measures. However, long-term or short-term droughts occur almost every year and they seriously jeopardize the production of raspberry. A particularly negative effect on the amount and quality of yields is achieved by drought in "the critical period" (phenophase from blooming to picking raspberry in June and July) when raspberry needs water the most. The intervention by irrigation becomes prominent and its use is the most effective, as in technological, as well as in economic sense. Irrigation „adapts itself" in agricultural production of raspberry manufacturers from Arilje, so it isn't a real obstacle for „the fight" against drought anymore.

Registered agricultural holdings of this area can count on incentives not only in raspberry production but in other fields of agricultural production from the budget of Ministry of Agriculture and the Environment Protection through the Directorate for Agrarian Payments. It is important to mention that, in determining the spatial-functional organization of the Arilje municipality area in future there should take care on every production factor which action must be respected during the investments planning and realization.

The yields of raspberry achieved so far are far away from those which can be achieved by taking into consideration the genetic potential of raspberry, but they are still satisfactory. Anyhow, Serbia is at the very top raspberry manufacturers in the world.
The essence of raspberry production with the use of irrigation is that it contributes to the growth of a holding's income and this income exceeds the growth of variable costs caused by irrigation, regarding that expenses for the application of this measure are not significantly represented in the structure of total variable costs.

As one of the important recommendations for the production of raspberry is also the use of renewable energy sources in the process of irrigation by solar panels and the introduction of this practice in Arilje raspberry-mount, since this achieves significant savings in irrigation and the investments in the purchase of solar panels refund quickly.

The state should coordinate programs and projects which promote the use of renewable energy sources and direct the financial support to users for the adoption and use of their results.

Literature

1. Allen, R. G., Pereira, L. S., Reas, D., Smith, M. (1998): *„Crop evapotranspiration"*. FAO irrigation and drainage paper, No 56. Rome.

2. FAO Bullten d'irrigation et de drainage (1984): Precipitation eficale. Rome. p.p. 1-40.

3. Gajić Boško, Tomić Zorica, Sredojević Zorica (2013): *„A simple method estimates and economic indicators of photovoltaic system for drip irrigation"*. Journal Economic of Agriculture. Year 60, No. 2 (217-436), pp. 223-237.

4. Kljajić Nataša (2012): *„Ekonomska efikasnost investicija u različitim uslovima proizvodnje maline"*. Doktorska disertacija. Poljoprivredni fakultet, Novi Sad.

5. Kljajić Nataša, Vuković Predrag, Arsić Slavica (2013): *„Tendencies related to the production of raspberries in the Republic of Serbia"*, Journal Economic of Agriculture. Year 60, No.1 (1-216), pp. 39-48.

6. Kljajić Nataša,Vuković, Predrag, Arsić Slavica, (2013): *„Current Situation in Irrigation in the Republic of Serbia"*, pp. 123-139. Charperter 7, Sustainable Technologies, Policies, and Constraints in the Green Economy Web site: http://www.igi-global.com http://resources.igi-global.com/production/proofs/Jean-Vasile/EditorProof.pdf

7. Kljajić Nataša (2014): *„Efikasnost investicija u proizvodnji maline"*. Monografija. Izdavač: Institut za ekonomiku poljoprivrede Beograd, broj strana 197.

8. Kljajić Nataša, Paraušić Vesna, Rodić Aleksandar (2016): *„Tehno-economic feasibility use of portable solar irrigation systems"*. 152nd EAAE Seminar: „Emerging technologies and the development of agriculture". Thematic proceedings. Novi Sad, Serbia. pp. 36-57.

9. Milivojević Jordan (1984): *„Efektivne padavine“*. Prilog metodologiji određivanja režima navodnjavanja. Doktorska disertacija. str. 119-125.

10. Milivojević Jordan, Gajić Boško, Bošnjaković Gorica, Cecić Nataša, Matović Gordana (2005): *„Optimizacija režima navodnjavanja zemljišta pod zasadima maline u različitim geomorfo-pedo-mikroklimatskim uslovima ariljsko-požeškog malinogorja“*. Završni izveštaj projekta tehnološkog razvoja u oblasti biotehnologije. str. 1-32.

11. Petrović S., Milošević T. (2002): *„Malina-Tehnologija i organizacija proizvodnje“*. Agronomski fakultet, Čačak. str. 215-219.

12. Sredojević Zorica, Kljajić Nataša, Popović Nikola (2013): *„Investing in raspberry as a opportunity of sustainable development of rural areas of western Serbia“*. Buletinul Revista categoria B+CNCSIS, Seria Stiinte Economice (M24), 2013, Petrol-Gaze din Ploiesti, 1/201, II (LXV), http://www.upg-bulletin-se.ro/archive/20131/6.Sredojevic_Kljajic_Popovic.pdf

13. Statistički godišnjak Republike Srbije, 2015. god.

14. http://www.novosti.rs/vesti/naslovna/ekonomija/aktuelno.239.html:578520-Srbija-na-prvom-mestu-u-svetu-po-proizvodnji-malina

15. https://adavinic.wordpress.com/2016/04/26/poslovno-udruzenje-hladnjaca-srbije-i-svetska-organizacija-iro-organizuju-svetski-susret-malinara/

16. http://arilje.org.rs/privreda/poljoprivreda.html (09.11.2016)

17. http://www.ains.rs/predavanja/AINS-VOCARSTVO%20SANSA%20POLJOPRIVREDE.htm

18. http://www.novosti.rs/vesti/naslovna/ekonomija/aktuelno.239.html:601982-Malinjaci-najvece-fabrike-u-Srbiji).