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WATER REQUIREMENTS OF FRUIT AND VINE PLANTATIONS IN THE AREA OF THE KOLUBARA DISTRICT IN PRESENT AND FUTURE CONDITIONS

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INTRODUCTION

Climate changes have resulted in frequent periods of droughts during summer months, as well as in the decrease and inadequate distribution of precipitation during the vegetation period. Therefore, irrigation is becoming a necessary measure in plant production required for reaching a high and stable yield. In order to satisfy food requirements of the global population and water requirements of other users, irrigation strategies have to be improved while maintaining the focus on water savings (Fereres and Evans, 2006). Fruit production without the application of irrigation is extremely uncertain and risky, particularly in arid and semi-arid regions of the world.

Fruit and vine production in the territory of the Kolubara District encompasses 15,685 ha, which accounts for around 15.3% of the total plant production. When it comes to fruit plantations, plums are the most represented (70%), while peaches and strawberries account for only 0.3%. The aim of this research was to determine the seasonal water requirements of fruit trees in climate change condition, to find out wheter will be changes in irrigation requirement. In addition, the paper includes the analysis of water requirements for the future periods in order to enable producers to adapt their agronomy practices and growing systems to the forthcoming conditions.

MATERIALS AND METHODS

FAO methodology (FAO Irrigation and Drainage Paper No. 56), was used to estimate the evapotranspiration, effective precipitation, crop evapotranspiration and water deficit, for 8 groups of fruit plantations: (I) apples, pears, plums, quinces, walnuts and hazels – the orchard without grass cover; (II) apples, pears, plums, quinces, walnuts and hazels – grassy orchard; (III) apricots and peaches – the orchard without grass cover; (IV) apricots and peaches – grassy orchard; (V) sweet cherries and sour cherries - the orchard without grass cover; (VI) sweet cherries and sour cherries - grassy orchard; (VII) strawberries, raspberries, blackberries and blueberries and (VIII) grapevine. The fruit plantations were categorised into the above-mentioned eight groups according to the length of the vegetation period and the crop coefficient values. The observed period from 2000–2019 and two future periods (2021–2040 and 2041–2060) were analysed.

Fruit trees included in the analysis and percentage of area

Culture	Group	Area (%)
apple, pear, plum, quince, walnut and hazel (frost, orchard without grass cover)	I	40
apple, pear, plum, quince, walnut and hazel (frost, grassy orchard)	II	40
peach and apricot (frost, orchard without grass cover)	III	0.4
peach and apricot (frost, grassy orchard)	IV	0.4
cherries (frost, orchard without grass cover)	V	1.1
cherries (frost, grassy orchard)	VI	1.1
strawberry, raspberry, blackberry and blueberry	VII	16.3
grapevine	VIII	0.7

The climate data for the reference 2000–2019 period were obtained from the meteorological station in Valjevo. Data for the future climate were obtained using 8 climate models for the RCP 8.5 climate scenario. The paper provides the results obtained as the median of the calculations for eight climate models.

Selected combinations of global and regional climate models

Regional climate model	Global climate model
CCLM4-8-17	ICHEC-EC-EARTH
CCLM4-8-17	MOHC-HadGEM2-ES.rcp85
CCLM4-8-17	MPI-M-MPI-ESM-LR
HIRHAM5	ICHEC-EC-EARTH
RACMO22E	ICHEC-EC-EARTH
RACMO22E	MOHC-HadGEM2-ES
REMO2009	MPI-M-MPI-ESM-LR
REMO2009	MPI-M-MPI-ESM-LR

CONCLUSION

The results of this research indicate the water requirements of fruit trees in the Kolubara District for the reference period (2000–2019) and two future periods (2021-2040 and 2041-2060). It can be noticed that there are no significant differences in the water requirements between the future periods and the reference period.

The obtained results can help producers analyse water deficit risks during the vegetation period of fruit trees and consequently apply appropriate agronomic practices in order to obtain a high-quality and stable yield.

RESULTS

The evapotranspiration value varies from 438.6, 429.0, and 440.5 mm for fruit trees from group V, to 892.2, 857.5, and 884.6 mm for fruit trees belonging to group II, with the average values of 596, 577.9, and 595.4 mm for the reference and 2021–2040, and 2041–2060 periods, respectively.

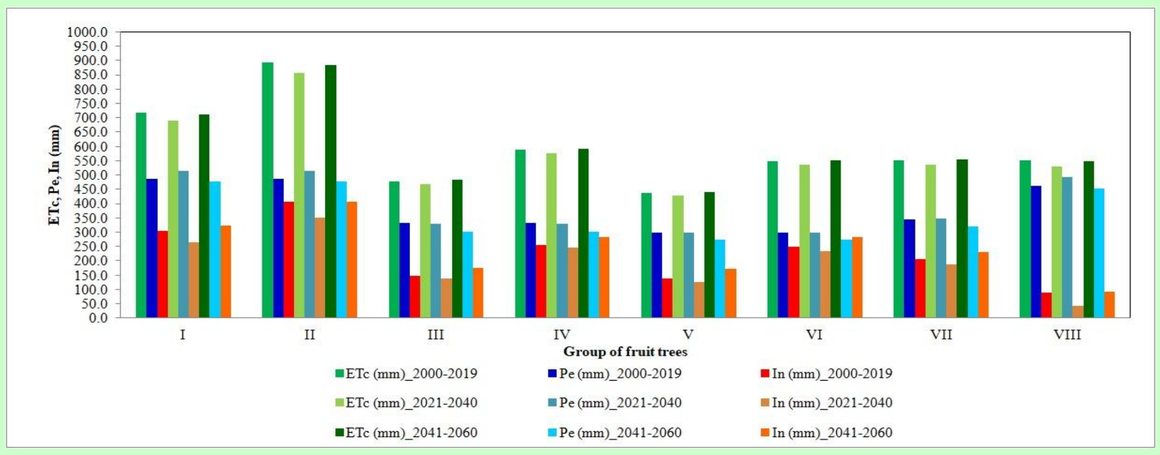
The seasonal water deficit varies from 88.0, 41.3, and 90.6 mm for grapevine (group VIII) to 405.6, 352.3, and 405.3 mm for fruit trees from group II, with the average values of 224.4, 198.7, and and 245.3 mm for the reference and 2021–2040, and 2041–2060 periods, respectively.

It can be noticed that water consumption is higher for all fruit trees in grassy orchards by approximately 24% on average than for those in orchards without a grass cover. Although evapotranspiration and water deficit are higher in grassy orchards, grassing over the orchards in the regions with sufficient precipitation creates favourable microclimatic conditions in orchards, which has a positive impact on the quality of fruits and protects soil from water erosion.

The comparison of water consumption of fruit plantations in different periods shows that there are no significant differences. In the period 2021–2040, 3% less water is used on average than in the observed 2000–2019 period. There are no differences between water consumption for the evapotranspiration process in the observed period and in the 2041–2060 periods. There is a slight increase (by 2%) in effective precipitation in the 2021–2040 in comparison to the reference period. In the 2041-2060 period, effective precipitation decreases by approximately 7%. The differences in the net water deficit (In) decrease by 14% in the 2021–2040 period compared with the reference period, while in the 2041–2060 period the net water requirements increase by 11% in relation to the reference period. In the month of July are the highest water requirements in all the analysed periods.

Crop evapotranspiration (ETc), effective precipitation (Pe), water deficit (In) during the vegetation season per fruit group for the observed 2000-2019 period and two future periods of 2021-2040 and 2041-2060

Group of fruit trees	I	II	III	IV	V	VI	VII	VIII	Average
Period	2000-2019								
ΣETc (mm)	717.3	**892.2**	478.7	588.3	**438.6**	549.5	552.4	551.3	596.0
ΣPe (mm)	486.7	486.7	332.2	332.2	299.6	299.6	346.1	462.6	380.7
ΣIn (mm)	303.6	**405.6**	146.5	256.1	139.0	249.9	206.3	**88.6**	224.4
Period	2021-2040								
ΣETc (mm)	689.5	**857.5**	468.8	574.8	**429.0**	537.4	536.4	530.1	577.9
ΣPe (mm)	513.5	513.5	328.8	328.8	298.8	298.8	348.2	494.0	390.6
ΣIn (mm)	264.8	**352.3**	138.4	245.1	126.4	234.4	187.0	**41.3**	198.7
Period	2041-2060								
ΣETc (mm)	711.2	**884.6**	482.0	592.5	**440.5**	552.1	554.1	546.7	595.4
ΣPe (mm)	478.4	478.4	302.3	302.3	273.7	273.7	319.7	452.3	360.1
ΣIn (mm)	321.7	**405.3**	175.8	283.2	172.8	283.6	229.2	**90.6**	245.3



Crop evapotranspiration (ETc), effective precipitation (Pe), and water deficit (In) during the vegetation season per fruit group, for the reference period (2000–2019) and two future periods (2021–2040 and 2041–2060)

Net (nNi) irrigation requirements for the reference period (2000-2019) and two future periods (2021–2040 and 2041–2060)

Period	2000-2019	2021-2400	2041-2060
nNi (mm)	278.4	243.4	292.5
nNi ($m^3 \cdot ha^{-1}$)	2783.9	2434.0	2924.8

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