COMPARISON OF PEAR TREE WATER NEEDS IN ISPARTA (TURKEY) AND BYDGOSZCZ (POLAND) REGIONS

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Abstract. The purpose of the study has been an attempt at a comparison of pear-tree water needs in the vegetation period in the Bydgoszcz region (Poland) and in the Isparta region (Turkey). The paper refers to the 1984-2014 temperature and rainfall values in the Bydgoszcz and Isparta regions. To determine the reference evapotranspiration (ETo), the calculation model by Hargreaves – modified by Droogers and Allen – was applied. Potential evapotranspiration (ETp), identified with pear-tree water needs, was determined with the method of crop coefficients proposed by Doorenbos and Pruitt. In each of the seven months considered (April-October) higher pear-tree water needs occurred in the Isparta region. The highest monthly pear-tree water needs were noted in July and in the studied period, respectively for the Bydgoszcz and Isparta regions, they were on average 105 mm and 215 mm. Pear-tree water needs throughout the vegetation period (April-October) were much higher (by 114 %) in the Isparta region than in the Bydgoszcz region. The highest rainfall deficits occurred in July and, respectively for the Bydgoszcz and Isparta regions, amounted to 33 mm and 195 mm.

Key words: pear tree, water needs, Bydgoszcz region, Isparta region.

Introduction

Pear fruit production in the world is approximately 22 million tons per year. The most important producers of this fruit are China (14.4 million tons), the USA (0.8 million ton), Italy (0.8 million tons). In Turkey, the pear is one of the main fruit crops and the fruit harvest of this plant is about 0.4 ml of ton [1].

In Poland, pear trees are also very popular among Polish fruit growers. The area of cultivation of this species in the years 2002-2015 - 10.1 thousand ha [2]. In 2016, the area of the crops decreased to 7.8 thousand ha and the fruit harvests obtained from pear orchards amounted to about 81.5 thousand tons. In Poland, pears constitute 2 % in the structure of harvest of all fruit from trees [3].

The water needs of fruit trees are varied [4-7]. Pear trees are classified as a group of plants with moderate water needs [4; 5]. The water deficit negatively affects the physiological parameters and yield of pear fruit. Trees subjected to prolonged water deficit usually produce smaller fruit and lower fruit yields [8-12]. In the literature there is information about cultivation or water requirements of fruits trees in the area of Isparta (Turkey) and Bydgoszcz (Poland) regions [7; 13]. There is also information about the comparative analysis of water needs for apple trees in the area of Isparta (Turkey) and Bydgoszcz (Poland) regions [14].

The aim of the present research was to compare pear-tree water needs in the vegetation period in the region of Isparta (Turkey) and the region of Bydgoszcz (Poland).

Materials and methods

The paper uses the thirty-year period (1984-2014) temperature and precipitation values for the Bydgoszcz and Isparta regions. To determine reference evapotranspiration (ET_0), the calculation model by Hargreaves, modified by Droogers and Allen [15], was applied:

$$ET_0 = HC \cdot Ra(T\max - T\min)^{HE}\left(\frac{T\max + T\min}{2} + HT\right),$$

where HC – empirical coefficients provided by the authors = 0.0025,
Ra – radiation over the atmosphere (mm·day^{-1}),
Tmax – maximum temperature, ºC,
Tmin – minimum temperature, ºC),
HE – empirical coefficient provided by the authors = 0.5,
HT – empirical coefficient provided by the authors = 16.8.

Potential evapotranspiration, identified using the pear-tree water needs, was determined by means of the plant coefficients method [16]. Coefficient *k* values for pear orchards at full development were used, as proposed by Doorenbos and Pruitt [17].

Results and discussion

Monthly pear tree water needs during the vegetation season (April-October) for the research period (1984-2014) in the Isparta and Bydgoszcz regions are shown in Figure 1. Cumulative pear tree water needs during the vegetation season in the region of Isparta amounted 926 mm, while in the Bydgoszcz region it was 434 mm.Pear tree water needs throughout the vegetation period (April-October) were higher by 114 % in the Isparta region than in the Bydgoszcz region.The highest pear tree water needs were reported in July and they amounted to an average of 215 mm and 105 mm for the Isparta and Bydgoszcz regions, respectively. Slightly lower pear tree water needs occurred in the successive summer months: August and June, respectively for the regions and months, amounting to 192 mm and 167 mm as well as 86 mm and 86 mm.Similarly, Rolbiecki et al. [14] performing a similar analysis for apple trees recorded significantly higher (by 120 %) apple water needs throughout the growing season (April-October) in the Isparta region than in the region of Bydgoszcz.

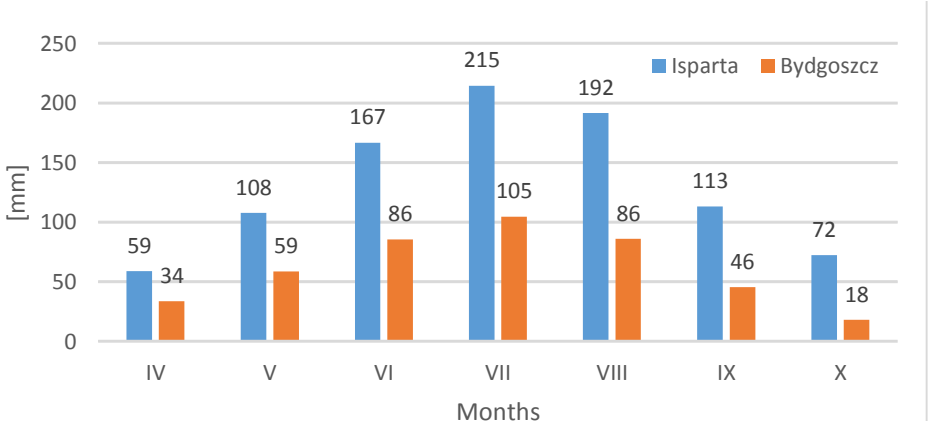

Fig. 1. **Monthly pear tree water needs during vegetation season (April-October) in Isparta and Bydgoszcz regions**

The highest rainfall deficits occurred in July for the Isparta and Bydgoszcz regions and were 195 mm and 33 mm, respectively. Monthly rainfall deficits during the vegetation season of the pear tree (April-October) in the Isparta and Bydgoszcz regions is shown in Figure 2. The water deficit negatively affects the physiological parameters and the yield of pear fruit [8-12]. According to Behboudian et al. [8] water deficit in pear cultivation is unfavorable, especially at the beginning of the growing season, because it negatively affects water relations, photosynthesis and fruit growth. Water stressaffects reductions in leaf and stem water potentials, leaf turgor pressure and gas exchanges [11; 18; 19]. In the research Morandi et al. [11] found that water stress negatively affects pear fruit growth by reducing first its xylem and then its phloem inflow. This determines a progressive increase in the phloem relative contribution to growth, which leads to the typical higher dry matter percentages of stressed fruit.

Natural precipitation deficits must be covered in respective months with water provided with supplementary irrigation. Cumulative pear tree irrigation needs during the vegetation season in the Isparta region amount to as much as 702 mm. In the Bydgoszcz region, the seasonal irrigation needs for pear tree were only 96 mm (Fig. 3). Higher irrigation needs in the province of Isparta compared to the region of Bydgoszcz result mainly from the smaller amount of rainfall during the vegetation season (April-October). In the Isparta province the sum of precipitation from April to October for the years 1984-2014 was only 223, whereas in the region of Bydgoszcz it was 351 mm (Fig. 4 and 5).

The irregularity of rainfall distribution in the growing season and the lack of repeatability of seasons, and even months in subsequent seasons cause that only irrigation can protect plants against the occurrence of drought [6; 20-24]. For high yields, fruit plants in Bydgoszcz region (Poland) should receive from 100 to 200 mm of water by applying supplementary irrigation in addition to natural precipitation [25; 26].

In the region of Isparta annual average rainfall is only 520 mm, 162 mm of this amount falls in the months May and October. Therefore, in order to obtain high yields, additional irrigation is needed in this region [13].

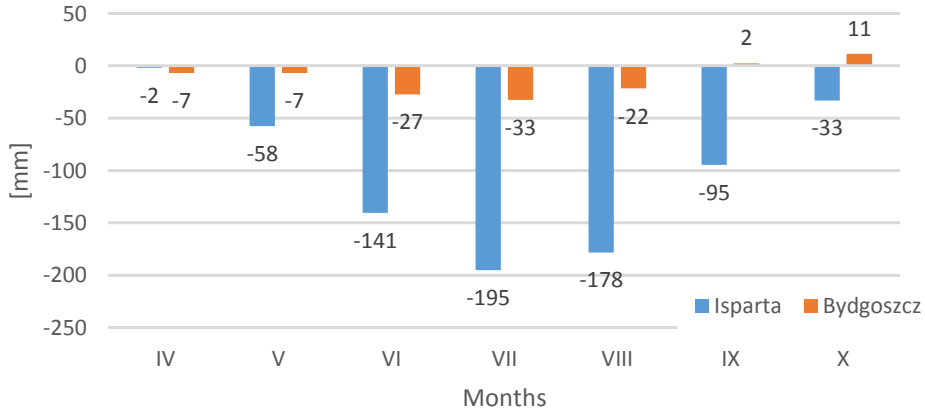

Fig. 2. **Monthly rainfall deficits during vegetation season of pear tree (April-October) in Isparta and Bydgoszcz regions**

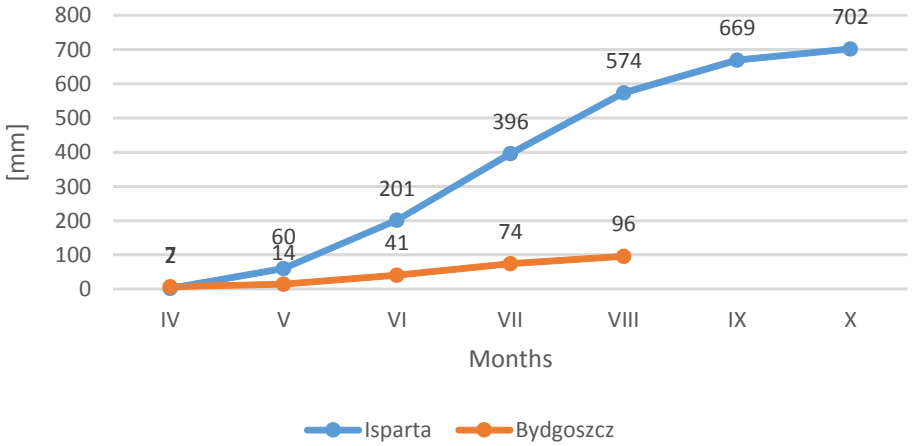

Fig. 3. **Cumulative pear tree irrigation needs during vegetation season (April-October) in Isparta and Bydgoszcz regions**

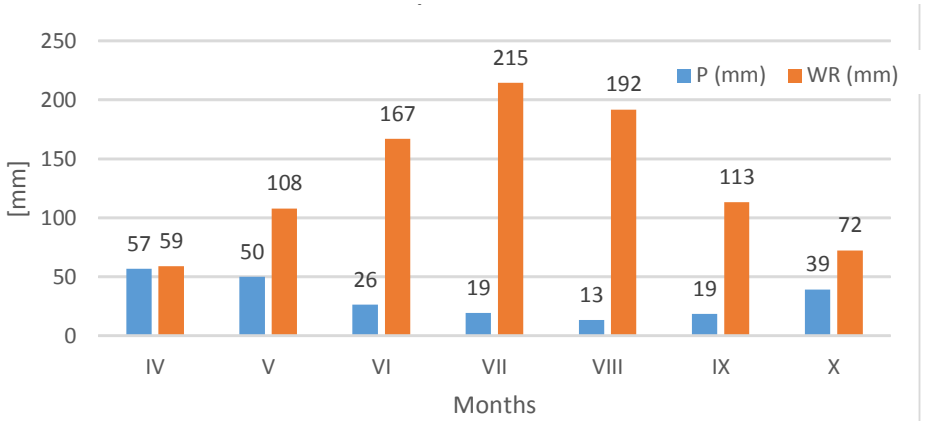

Fig. 4. **Course of pear tree water needs (WR) and rainfall (P) during vegetation season (April-October) in Isparta region**

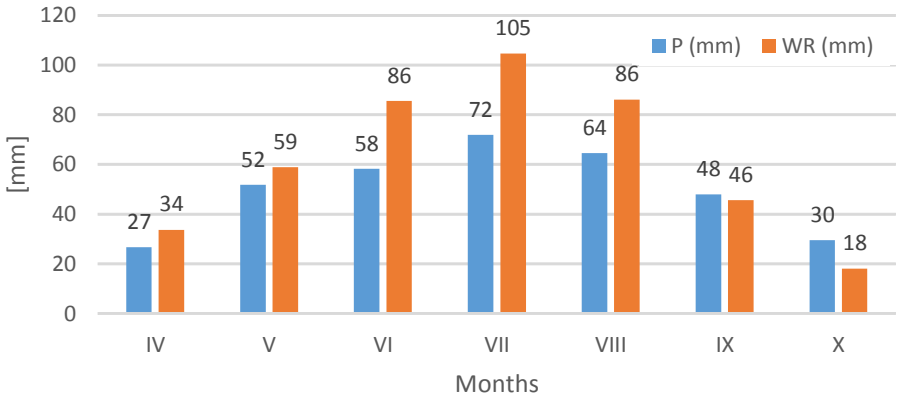

Fig. 5. **Course of pear tree water needs (WR) and rainfall (P) during vegetation season (April-October) in Bydgoszcz region**

Conclusions

Pear tree water needs during the vegetation season (April-October) for the research period (1984-2014) throughout were higher by 114 %. % in the region of Isparta (Turkey) in comparison to the region of Bydgoszcz (Poland). The highest monthly pear-tree water needs were noted in July and in the studied period, respectively for the Bydgoszcz and Isparta regions, they were on average 105 mm and 215 mm. The highest rainfall deficits occurred in July and, respectively for the Isparta and Bydgoszcz regions, amounted to 195 mm and 33 mm. Cumulative pear tree irrigation needs during the vegetation season in the Isparta region amount to as much as 702 mm, while in the region Bydgoszcz only 96 mm. Higher irrigation requirements in the province of Isparta compared to the region of Bydgoszcz result not only from the smaller amount of rainfall, but also from the differences in distribution of rainfall during the vegetation period.

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