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Full Length Research Paper

Does climate change have an effect on proline accumulation in pomegranate (*Punica granatum* L.) fruits?

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Pomegranate is one of the oldest subtropical fruits cultivated in Turkey and surrounding areas. The country has very rich pomegranate genetic resources mostly found in semi-arid and arid areas. In this study we examined change of proline content in three well known pomegranate cultivars namely Hicaz, Oguzeli and Devedisi in year 2007 and 2008. There were wide climatic differences between years and 2008 were found to be more dry and hot compared to 2007. The proline content varied among pomegranate cultivars and particularly years. In year 2007, average proline content of three pomegranate cultivars were 30 mg/l while it was 93 mg/l in year 2008, indicating that climatic change affects proline accumulation in pomegranate fruits and in hot and dry years, proline accumulation in fruits increases.

Key words: Pomegranate, climate changes, desertification, proline.

INTRODUCTION

Climate changes, as a result of globalization, one of the important issues in 21st century and its effects are more visible on agriculture. Extreme rises in temperatures and decrease in rain affect the underground water resources. The underground water resources change the chemical structure of the soil and chemical structure of transformed soil, affects the chemical composition of the trees, shrubs and their fruits which are grown in same ground (Grantz et al., 2003)

Currently at least 100 countries faces a potential danger of desertification. United Nations Environment Program (UNEP) foresees the global cost of desertification as 42 billion USD per year. According to the predictions of the Worldwatch Institute, continents (mainland) suffer about 24 billion tons of fertile top soil loss in each year (Anon, 2009).

One of the major problems caused by drought is soil salinity. Especially in arid and semi-arid climatic regions, inadequate rainfall and high evaporation are the top reason of the salinity. In the world, every year, 10 million hectares of land are destroyed due to the salinity problem (Kwiatowski, 1998).

Pomegranate (*Punica granatum* L.) is believed to have originated from Southern Caspian belt (Iran) and Northeast Turkey (Janick, 2007) and the Mediterranean basin is an important diversification center of the plant (Levin, 1994). It has high adaptation capacity and therefore, as a crop, it is widely cultivated in the tropical and subtropical areas, mainly in the Mediterranean countries including Egypt, Morocco, Spain, Turkey and Tunisia (Salaheddin and Kader, 1984; Melgarejo and Martinez, 1992).

Turkey is one of the native lands of the pomegranate and the cultivation of pomegranate (*Punica granatum* L.) is mainly confined to semi-arid mild-temperate to subtropical climates including Mediterranean, Aegean and South East Anatolia region in the country (Ercisli, 2004; Ozgen et al., 2008). The country has also long history on pomegranate cultivation. The total amount of pomegranate production of Turkey is approximately 100,000 metric tons for each year (Ercisli et al., 2007).

The edible part of the fruit is called arils. The fresh juice contains 85% moisture and considerable amounts of total soluble solids (TSS), total sugars, reducing sugars, anthocyanins, phenolics, ascorbic acid (vitamin C) and

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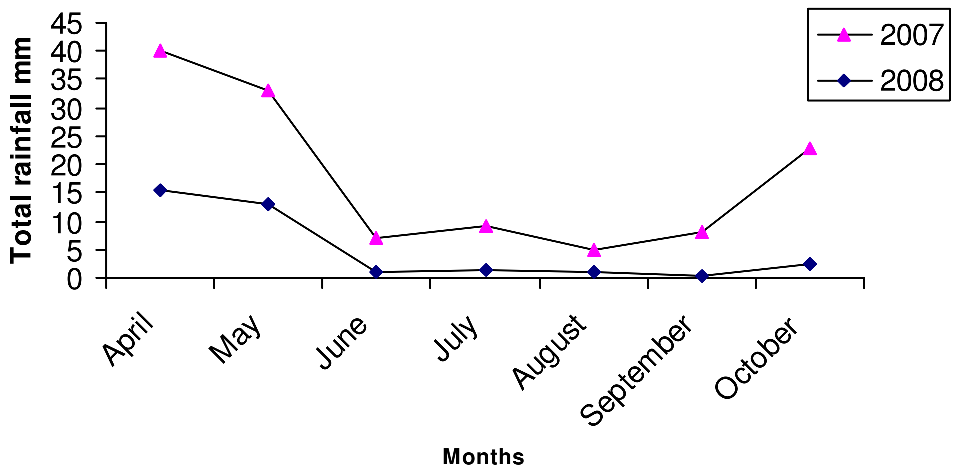

Figure 1. The change of average total rainfall (mm) in fruit sampling areas.

proteins (El-Nemr et al., 1990) and has also been reported to be a rich source of antioxidants (Gil et al., 2000; Kulkarni and Aradhya, 2005).

Proline is one of the twenty amino acids that are used by living organisms as a building block of proteins (so called proteinogenic amino acids). It is a useful indicator for the impact of CO_2 and drought stress in plants (Hudak et al., 1999). In drought stress conditions, proline content in plant is increase. It also acts as a free radical scavenger and may be more important in overcoming stress than in acting as a simple osmolyte (Ramachandra et al., 2004; Verslues and Bray, 2006).

Although there are some studies which show that salty soil raise the proline quantity in mango, olive varieties and pomegranates leafs, such study is not available for pomegranate fruit itself. Proline content of pomegranate which grows in Turkey and changes as a result of climate change was examined in order to eliminate the deficiency found in the literature.

MATERIALS AND METHODS

In this research, three well known pomegranate cultivars in Turkey such as Hicaz, Oğuzeli and Devedisi were used and these materials were obtain from the Mediterranean, Aegean and Southeastern Anatolia regions. The proline content at harvest in both 2007 and 2008 has been determined. Approximately 1 kg pomegranate juice was obtained from the three cultivars by pressing. Proline analysis of pomegranate juice has been performed by using spectrophotometer method in accordance with TS EN 1141 (Anon, 1996). The climatic data of experimental area are also recorded.

RESULTS AND DISCUSSION

As indicated in Figure 1, there were climatic differences on areas of pomegranates samples between year 2007 and 2008. The climate was more hot and dry in year 2008 compared to 2007 (Figure 1).

Figure 2 shows proline variation among cultivars in both years. As can be seen in Figure 2, the highest proline content was observed in cv. Oguzeli as 34 mg/l, followed by cv. Devedisi (30 mg/l) and cv. Hicaz (26 mg/l), respectively. Average proline content of three cultivars was 30 mg/l in year 2007.

Figure 2 explain proline content of the three pomegranate cultivars in year 2008. It is very clear that proline content of cultivars were increased 3-folds compared to year 2007. In year 2008, the highest proline content was observed in cv. Oguzeli (96 mg/l) as it was in year 2007, followed by cv. Hicaz (92 mg/l) and cv. Devedisi (90 mg/l), respectively. The average proline content of three cultivars was 93 mg/l in year 2008 (Figure 2). Previously, genotype depended proline accumulation has been reported in bean (Jimenez-Bremont et al., 2006). It is also reported that proline accumulation varied by various climatic conditions as a result of water deficit and saline environments (Taylor, 1996).

Previously, a wide variation on proline content in pomegranate juices was determined. For example Velioglu et al. (1997) reported proline content in pomegranate juices as 7.70 mg/l but Unal et al. (1995) reported its value as 23 mg/l. Saeed (2005) examined the effect of 4000 and 6000 ppm salt water on proline accumulation in pomegranate leaves. The proline amount in the leaves of the pomegranate, irrigated with tap water was determined to range from 38.32 - 46.50 mg/g FW. However, 6000 ppm salt water treatments resulted in 50.58 - 62.93 mg/g FW proline content. The amount of proline in the samples irrigated with 4000 ppm concentration salt water was slightly lower than 6000 ppm. Similar trends were observed in olive (Atta, 2002; El Sayed et al., 1995) and mango (El Hamady et al., 1993). Despite the large number of results published regarding the chemical composition of pomegranate, there is not enough datas about amino acid composition and proline amount. How-

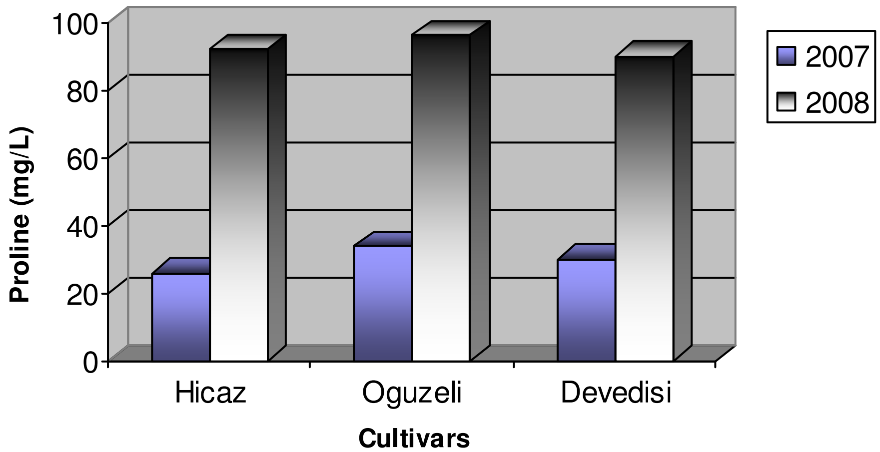

Figure 2. Proline amounts of pomegranate cultivars harvested at 2007 and 2008.

However, a wide variation related to proline (304 - 4600 mg/l) was observed in grapes (Anon, 1992).

Studies revealed that chemical composition of pomegranates depends on genotypes, ripeness, variations and growing areas (Unal et al., 1995; Kulkarni and Aradhya, 2005; Melgarejo et al., 2000; Poyrazoglu et al., 2002; Ozgen et al., 2008; Tezcan et al., 2009). It may also vary as well in very wide limits depending on climatic changes and the structure of soil.

Proline is small molecules, which are synthesized after suffering intimidation action (Hu et al., 2006). These molecules are strongly hydrophilic and alleviate stress damage in plant cells by reducing the water potential and keeping the activities of some biological macromolecules (Rathinasabapathi, 2000). Accumulation of organic compounds such as proline in the cytoplasm also plays an important role in osmotic adjustment in plants (Watanabe et al., 2000).

There is extensive literature indicating that drought stress induces an accumulation of proline (Bradford and Hsiao, 1982), suggesting that the amino acid may be a useful early indicator of drought stress effects, although there is evidence in the literature that proline accumulation seems to occur only when plant growth is already retarded by drought stress (Aspinall, 1986). Small plants of *Cistus ladanifer* reached lower water potentials and also higher concentration of proline than bigger plants (Lansac et al., 1994). The accumulation of free proline has been related to drought resistance in *Hordeum disticum* L. (Singh et al., 1973) and sorghum (Sivaramakrishnan et al., 1988). Seasonal variation of free proline content in evergreen sclerophylls has been shown by Diamantoglou and Rhizopoulou (1992).

As a result, proline could possibly be used as a drought stress indicator in pomegranates. This study includes and proposes rather too many short-period indicators. Climate change is a long timescale phenomenon. The results also draws attention for the need of further research to understand the complexity of multiple stress interactions involved in the modification of plant responses to predicted changes in climate.

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