

P 21: Study of self-pollination and capitula characteristics in globe artichoke (*Cynara cardunculus* var. *scolymus* Hayek L.) under different irrigation regimes



Sina Nouraei, Mehdi Rahimmalek, Ghodratollah Saeidi

Department of Agronomy and Plant Breeding, College of Agriculture, Isfahan University of Technology, Isfahan 84156 83111. Corresponding author email address: sina.nooraeie@gmail.com

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Abstract

In order to estimate the drought effects on capitula characteristics and self-pollination of globe artichoke (*Cynara cardunculus* var. *scolymus* Hayek L.), the randomized complete block design was carried out with three irrigation regimes (20 %, 50 % and 80 % depletion of soil available water) and six replicates. The artichoke is mostly open-pollinated, however, after covering the buds and isolation of flowers to prevent cross pollination, 1.79 % self-pollination was observed and this amount was not affected by different irrigation regimes. In stress conditions (50 % and 80 % water depletion) as well as non-stress condition (20 % water depletion), plants with respectively one and two medium capitula and without small capitula had most relative frequencies in the population and drought stress increased these relative frequencies by reducing the number of medium and small capitula in plants. In addition, Capitula size and dry weight were significantly affected by water stress. Water shortage induced severe decrease in length and dry weight of all capitula including large, medium and small, although capitula width was less affected by water deficit and only slight decline in medium (12.5 %) and small capitula (23.7 %) was observed under severe stress condition.

Keywords: Artichoke, water stress, pollination, capitula characteristics

Introduction

Decreasing in water sources as a result of climate change, in combination with increasing population and increasing societal water demands lead to water shortage being one of the most important global issues. Drought negatively impacts plant growth and reduced crop yield more than other causes (Ings et al., 2013). Globe artichoke (*Cynara cardunculus* var. *scolymus* Hayek L.) is perennial, tall thistle-like plant of the Asteraceae family with edible and medical applications from Mediterranean origin. Buds of artichoke (capitulum) considered a healthy food due to low fat and cholesterol, while being a rich source of fiber, vitamins and minerals (Lattanzio et al., 2009).

The terminal, or top artichoke bud is the largest one in the stem, and others that formed below this terminal bud will be progressively smaller. Different irrigation conditions could influence capitula characteristics and change bud yield and quality, consequently (Green, 2013). Plant pollination system is very important since determine the crossing possibility and breeding method and also could be affected by different irrigation regimes (Chahal and Gosal, 2002).

Materials and Methods

The field experiment was designed as a randomized complete block with three irrigation regimes (three treatments) and six replicates in research farm of Fozveh that is located in west side of Isfahan (32°36'N; 51°26'E and 1612 m above the mean sea level), Iran. Irrigation regimes including 20 %, 50 % and 80 % depletion of soil available water were introduced as non-stress, moderate water stress and severe water stress conditions, respectively based on method of Allen et al. (2000). The irrigation time was adjusted through creating soil moisture curve obtained by time domain reflectometry (TDR) device (Model Sabta Barbara 6050X).

Sampling was conducted when the immature buds were firm and tightly closed and proper for use (marketing stage). Capitula length and width were measured with coulisse. For capitula dry weight determination, the samples were oven-dried at 80 °C for 72 h and then weighed. Pollination was excluded through the use of pollination bags.

Results

Drought stress significantly affected all capitula characteristics, although large capitula width and selfing percentage did not change significantly under different irrigation conditions (Table 1). The dry weights reduction in moderate and severe water stress regime were 25 %, 45.5 % in large, 16.6 %, 42.6 % in medium and 8.2 %, 39.7 % in small capitula, respectively (Fig. 1 a). So, the highest reduction in dry weight in both moderate and severe stress environments was happened in large buds and lowest reduction was observed in small ones. The length of large, medium and small capitula was decreased by drought intensification (Fig. 1 b). The width of large capitula was not affected significantly, and only in medium and small capitula under severe stress condition, significant change in capitula width was observed (Fig. 1 c). It was revealed that the reduction in size of artichoke buds (as it was confirmed with reduction in capitula dry weight) could be mostly attributed to reduction in buds length than width.

In respect to capitula numbers, all of artichoke plants had a one terminal bud in end of main stem that was the largest and the heaviest ones. The number of others buds (medium and small) varied (from zero to six) in different plants and under different irrigation regimes. One medium capitula plant with 40 %, 37.5 % and 46.8 % relative frequency in non-stress, moderate and severe stress had the highest frequency in the population and after that two medium capitula plant with 29.7 %, 32.1 % and 34.3 % relative frequency had the highest frequency in non-stress, moderate and severe stress condition (Fig. 1 d). Results showed that the moderate stress caused the reduction in one medium capitula frequency and elevation in frequency of two medium capitula plant in comparison with non-stress condition; however, severe water stress increased both one and two medium capitula frequency in comparison with non-stress condition by reduction in the number of medium buds (Fig. 1 d). Also plants without small capitula had the highest frequency with 58.3 %, 64.2 % and 75 % relative frequency in non-stress, moderate and severe drought stress, respectively. Similarly drought stress caused elevation in the plants without small capitula by reduction in the number of small buds (Fig. 1 e).

Variance analysis showed no significant difference between the percent of self-pollinated seeds under different irrigation regimes. The means of this trait was 1.79 %, and didn't change significantly by drought stress (Table 1). Artichoke is a cross pollinated plant that pollination can be done by insects (mainly by bee) or other vectors. Although, *C. scolymus* is self-compatible, reproduce viably via self-fertilization is very rare. The reason is that the flowers are protandrus and stigma is receptive 5-7 days after the pollen grains are released. Hence, the pollen grains remain alive only for 3 days in filed condition; therefore the selfing possibility is low. In addition, three genes for nuclear male-sterility have been reported, (ms1, ms2 and ms3) that might be another reason to avoid from inbreeding (Basnizki and Zohary, 1994). In overall, no change in the percent of self-pollinated seeds in different irrigation regimes could be attributed to the fact that pollination is mostly controlled by genetic factors and rarely affected by environmental factors.

References

- Allen, R.G., Pereira, L.S., Raes, D. and M. Smith, 2000. FAO irrigation and drainage paper. Crop Evapotranspiration 56, 1-326.
- Basnizki, J. and D. Zohary. 1994. Breeding of seed-planted artichoke. Plant Breeding Reviews 12, 253-269.
- Chahal, G.S. and S.S. Gosal, 2002: Principles and Procedures of Plant Breeding, Alpha Science International Ltd., Pangbourne.
- Green, W., 2013. Vegetable Gardening the Colonial Williamsburg Way: 18th-century Methods for Today's Organic Gardeners, Rodale Books, New York.
- Ings, J., Mur, L.A.J., Robson, P.R.H. and M. Bosch, 2013. Physiological and growth responses to water deficit in the bioenergy crop *Miscanthus x giganteus*. Frontiers in Plant Science 4, 1-12.
- Lattanzio, V., Kroon, P.A., Linsalata, V. and A. Cardinali, 2009. Globe artichoke: a functional food and source of nutraceutical ingredients. Journal of Functional Foods 1, 131-144.

Tab. 1 variance analysis of artichoke capitula traits and selfing percentage at three levels of irrigation

	Source of variation		
	Replication	Irrigation treatment	Error
df	5	2	10
Large Capitula Length	0.505*	5.051**	0.117
Large Capitula Width	0.092 ^{ns}	0.551 ^{ns}	0.291
Large Capitula Dry Weight	15.83 ^{ns}	569.08**	12.05
Medium Capitula Length	0.676*	2.347**	0.139
Medium Capitula Width	0.205*	0.325*	0.064
Medium Capitula Dry Weight	18.59 ^{ns}	158.6**	8.285
Small Capitula Length	0.563*	2.931**	0.141
Small Capitula Width	1.577 ^{ns}	1.282*	0.19
Small Capitula Dry Weight	7.5 ^{ns}	17.05*	2.98
Selfing	0.18 ^{ns}	0.13 ^{ns}	0.115

*, ** Significant at the 5 and 1 % levels of probability, respectively

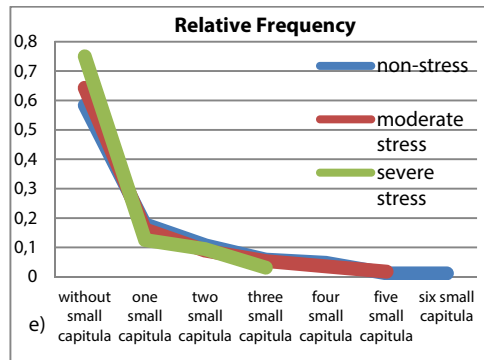
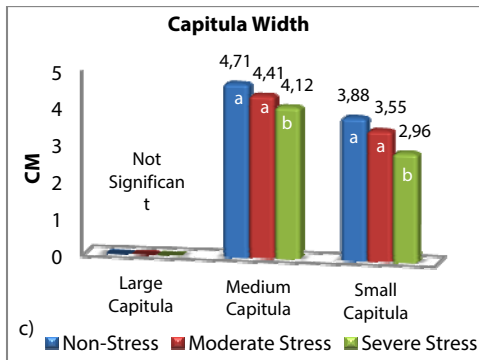
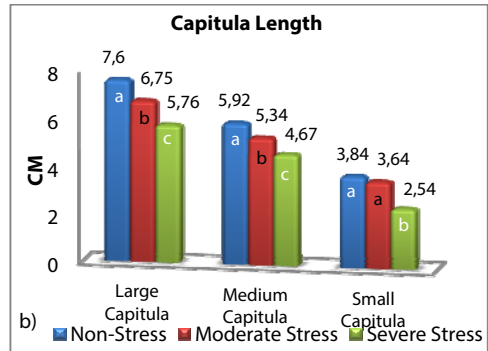
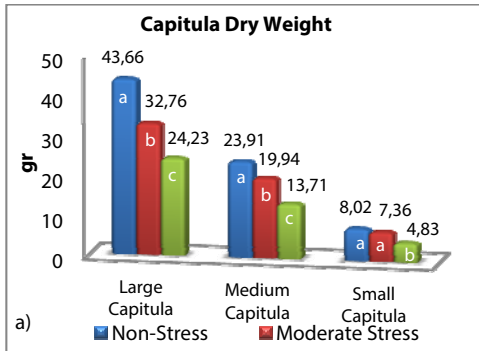


Fig. 1: a) Capitula dry weight b) capitula length c) capitula width d) relative frequency of plants with different number of medium capitula e) relative frequency of plants with different number of small capitula under different irrigation regimes.

