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Increasing Water Use Efficiency in Saffron (*Crocus sativus* L.) Cultivation

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Abstract
An experiment was conducted at the Gonabad Research Station of Agriculture and Natural Resources, Iran to demonstrate the effects of moisture stress on saffron yield and quality in 2012 and 2013. The statistical design was a randomised complete block design with five treatments and four replicates. The treatments were: irrigation till 70% field capacity (FC), 60% FC, 50% FC, first control (three irrigations), and second control (three irrigations + one in mid summer). Quantitative measurements were number of flowers, fresh weight of flowers, dry stigma, number of corms and corm weights, as well as at the end of the experiment amount of corm covering, and dry weight of leaves. Quality measurements included amount of picrocrocin, crocin and safranal. Combined analysis for two years showed no significant effects on quantitative characteristics but high significant effects on quality characteristics. By reducing irrigation to 50% FC quality factors increased and showed positive effects of moisture stress on saffron quality. However, there was a trend of decreasing quantity characteristics because of a reduction of soil moisture content. For increasing saffron stigma yield three irrigations + one irrigation in mid summer is optimum. For increasing the amount of picrocrocin, crocin and safranal a moisture stress is desirable. Actually, efforts are necessary to increase water use efficiency (WUE) in saffron with respect to the actual used 3000 m^3/ha water for an economical yield. Such a WUE optimization is especially necessary because of recent drought years in the main areas of saffron cultivation in the great Khorasan. The results of this experiment showed that moisture stress as much as 70% FC can be recommended for both saffron quantity and quality.

Keywords: Quality factors, saffron covering, stigma.

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Introduction:

Saffron(*Crocus sativus* L.) is adapted to arid and semi arid lands of Iran.Saffron is a low requirement water crop.Saffron is among few crops that is very important as an export non-oil product.It has a vital role in providing income and job creation.Saffron is the most important agricultural product of provinces Korasan-Razavi and South Khorasan (Hosseini et al.2003). Afghanistan,Greece,Morocco,Kashmir,Spain and Italy are other producers of saffron with negligible amounts. Iran as home of saffron has always been the first rank for cultivation area with an increasing trend and total production.According to staistics of 2017 produced saffron of Iran was 336 t that is accounted for about 88.8% of saffron world production..At present,cultivation area is about 105000 ha(MJA,2017). Due to drought years,saffron yield has decreased considerably in recent years.In fact,Iran is the greatest producer and exporter country of the world at an international scale.Other aspects of saffron cultivation its high water use efficiency and also job creation,prevention from immigration,and its significance as a non oil export item.Iran policy makers have decided on increasing its export.Saffron is a plant with specific biological characters adapted to arid lands of the world with water deficiency(Kafi et al.2002).Research has conducted on saffron irrigation to increase water use efficiency and coping with extra use of water and preventing from water waste(Sadeghi,1997).Low water for irrigation as a strategic method,valuable and sustainable is in arid lands of the world .In this method the purpose is to maximize water productivity and crop yield stabilization not to maximize crop yield(Greets and Raes,2009).Lage and Cantrell (2009) suggested that saffron is the only and important crop suitable for main lands of cropping systems of Morocco as a sustainable crop.Mollafilabi and Davari(2006) showed drip irrigation is optimum for saffron irrigation. Sadeghi et al(2014)suggested that Iran can export saffron as much as one billion dollars by enlarging corms for one year and delivering them to saffron farmers for planting at the first year of cultivation. The aim of this study was to determine optimum amount of irrigation water based on soil field capacity in order to minimize irrigation water and obtaing maxmimum economical saffron yield.

Materials and methods:

The research project of "Effects of moisture stress on saffron(Crocus sativus L.) quantitative and qualitative characters " was conducted at the research station of Agriculture and Natural Resources of Gonabad for 2 successive years.This research was as Randomized complete block design(RCBD) with five treatments and four replicates.Treatments were as follows:70% field capacity(FC) means based on weight moisture equal to 11.2 % moisture with irrigatin interval every 6 days,60% FC means based on weight moisture equal to 9.6 % moisture with irrigation interval every 15 days,50% FC means weight moisture equal to 8% moisture with irrigation interval every 25 days,first control(C1) based on traditional method means four irrigations in times of early fall to facilitate flowering,post picking up flowers,in mid winter,and at the end of growing season(early May),and the second control(C2) that in addition to the above traditional method one irrigation in early August(mid summer).The treatments in the first irrigation and the second irrigation were similar in all plots for irrigation and all experimental treatments were applie after the second irrigation up to early May.Plot dimensions was 1* 2 equal to 2 m2 and planting depth of corms was 20 cm.100 saffron corms were used for each plot with 6-8 gr weight of each corm.Irrigation water in each plot and for each time was 5 cm and equal to 100 litre.Row interval was 20 cm and corm distance was 10 cm on each row. 24 hr after irrigation Fc equal to 16 % weight moisture obtained that later treatments were applied according to amounts under consideration.SAS and Minitab statistical packages were used to analyse data.Quantitative and qualitative characters for measurement were as follows:number of flowers,fresh weight of flowers,dry weight of stigma(economical yield(,number of corms at the end of the experiment,corm weight at the end of the experiment,dry weight of leaves and produced corm covering all at the end of the experiment,rates of picrocrocin,crocin,and safranal averaged for the 2 year period of the study.Field capacity (FC) method was based on pressure plates (Chen et al.2009) and qualitative measurements were by spectrophotometry(UV-vis)(ISIRO,1997).

Results and discussion:

It is evident that different treatments of moisture had significant effect on flower weight,dry stigma,rates of safranal ($p \leq 0.05$) and on rates of crocin and picrocrocin ($p \leq 0.01$).By increasing moisture stress rates related to qualitative characters decreased that has been reported by others frequently(Karafyllidis et al.1996) .On the contrary,increasing moisture stress is along with plant ingredients accumulation.It is evident that saffron yield rise is up to the point of maximum quality factors including picrocrocin,crocin,and safranal.It emphasizes on a negative correlation between quantitative and qualitative factors .

Results obtained based on a two year average showed that there was no significant effect for quantitative factors as mean comparisons but it had significant effects on quality factors(Figure).

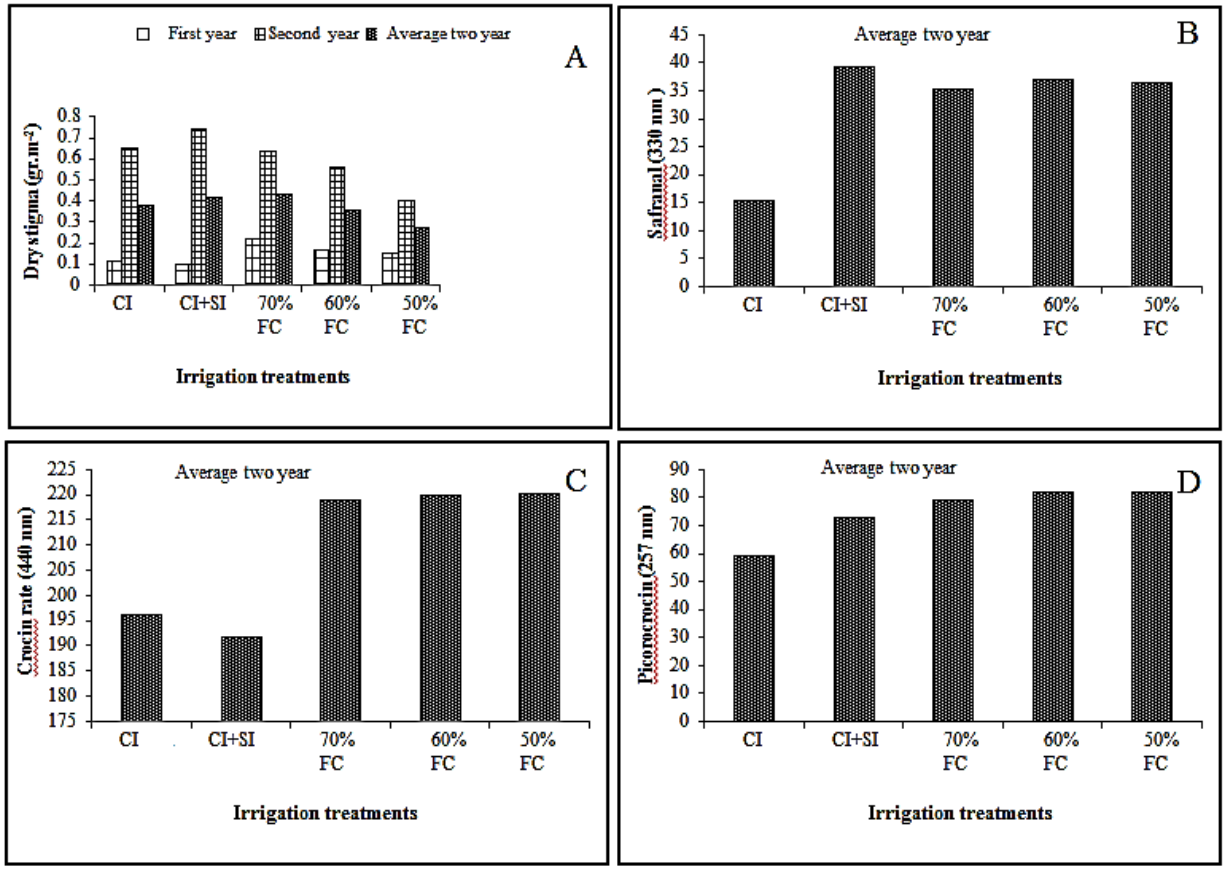

Figure: CI:conventional irrigation(four times irrigation in respective phenological stages of saffron as traditional method.CI+SI:conventional irrigation plus one irrigation in mid summer. A.Effects of irrigation traetments on dry stigma.B.Effects of irrigatin treatments on safranal content.C.Effects of irrigation treatments on crocin content and D.Effects of irrigation treatmnets on picrocrocin content.

Conclusion:
To optimize water use in saffron will cause to cultivate sustainable saffron production because recent drought years in main areas of saffron cultivation in the great Khorasan .The results showed that moisture stress as much as 70% field capacity (FC) can be recommended for both saffron quantity and quality aspects.In arid regions of the world sustainability of cropping systems is important not maximizing crop yield.This concept causes to create job for farmers and provide income and the most important factor cause to prevent from immigration in these areas that challenge with increasing water deficiency.

References:

Chen, H.,Wei, C., Yan, R., and Chen,P. 2009. On the determination of the soil-water characteristics curve using the pressure plate extractor.Proc.of Int. Symp.on Geoenvironmental Eng.ISG.Hongzhu.China.

Greets,S.,and Raes,D.2009.Deficit irrigation as an on-farm strategy to maximize crop water produtivity in dry areas.Agricultural water Management 96,1275-1284.

Hosseini,M.,Hemmati-Kakhki,A.,and Karbasi,A.R.2003.Study of social and economic effects of ten years research on saffron.3rd National Symposium on saffron.Mashhad.Iran.

Institute of Standard and Industrial Research Organization of Iran(ISIRO).1997.Saffron methods testing.National Iranian Standards.No.259-2. (Persian)

Kafi,M.2002.Saffron:Technology of production and processing.Center of Excellence of Agronomy.Faculty of Agriculture.Ferdowsi University of Mashhad.Iran.

Karafyllidis,D.I.,Staravopoulus,N.,and Georgakis,D.1996.The effect of water stress on the yielding capacity of potato crops and subsequent performance od seed tubers.Potato Research 39,153-163.

Lage,M.,and Cantrell,C.L>2009.Quantification of saffron metabolites crocin,picrocrocin,and safranal for quality determination of the spice grown under different environmental Moroccan conditions.Scientia Horticulturae 121,366-373.

Ministry of Jahad of Agriculture(MJA).2017.Saffron Report.Office of National Priject of Medicinal plants.

Mollafilabi,A.,and Davari,K.2006.Comparison of different methods of saffron irrigation.Research project.Khorasan Research Inst.of Food Sci. and Tech.Mashhad.Iran.

Sadeghi,B.,Hosseini,M.,and Masroori,M.2014.Effects of plant nutrition in saffron planting bed for corm enlargement.Research Inst. Of Food Sci. and Tech.(RIFST).mashhad.Iran.

Sadeghi,B.1997.Effects of summer irrigation on saffron(Crocus sativus L.) yield.Publication of Iranian Research Organization for Science and Technology(IROST).Mashhad.Iran.