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Research Article

EFFECTS OF DEFICIT IRRIGATION AND MULCH ON VEGETATIVE AND REPRODUCTIVE TRAITS OF GRAPE

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ABSTRACT
Due to reduced rainfall and limited irrigation in recent years, the need for fundamental changes in irrigation management of the fruit orchards is felt. Thus, understanding the reactions of fruit trees to the drought stress are important and water supply required at critical stages of plant growth can adversely decrease drought stress. In years of low rainfall, the vineyards that are planted as rain-fed or with supplemental irrigation may be affected by drought. Therefore, applying management methods such as the use of mulch cover for better use of water resources and in order to minimize water stress appears to be essential. The subject of this study is to investigate and evaluate the application of mulch cover and deficit irrigation on vegetative and reproductive traits of grape in order to achieve a correct management of the irrigation. The results showed that the interaction effects of irrigation and mulch treatments were significant on yield, branch length, weight and number of cluster. Also, it has been demonstrated that mulch could adjust the reduced amount of vegetative growth and yield of fruit trees in the severe water stress.

Keywords: *Deficit Irrigation, Grapes, Mulch, Yield*

INTRODUCTION
Water is a main factor in agriculture. So drought period during plant growth season may reduce yield and plant growth. In wide area of Iran, the grape trees cultivated without irrigation (rainfed) or with supplementary irrigation. These gardens during years with low rainfall are under severe drought stress. In this condition, supply of enough water for gardens are difficult; therefore can lead to yield loss. Water stress leads to a series of physiological responses of plant as reduce in photosynthesis. Also, water stress reduces foliage growth and fruit development that its severity dependent on drought stress time and stress intensity (Goodwin, 2002). So applying different methods of irrigation management practice for better use of water resources and increase irrigation efficiency is essential.
Proper method for schedule irrigation have very important role for drought stress management including reduced deficit irrigation (RDI), partial root dryness (PRD) and mulching play a key role in this context (Chaves *et al.*, 2007; Campbell-Clause and Fisher, 1999; Costa *et al.*, 2007).
Use of deficit irrigation on fruit trees as peaches, plum and grape was significantly more successful than crop plants. Studies have shown that supply of tree water based on the total evapotranspiration (ET) method is not an optimal management of irrigation (Holzapfel *et al.*, 1988). With using of regular deficit irrigation the amount of consumed water per unit of production decreases without any reduction in fruit quality and quantity. So deficit irrigation can serve as a useful tool to improve irrigation management in arid and semiarid area (Holzapfel *et al.*, 1988). Also the use of mulch is one of the most effective ways to retain moisture during periods of drought and can be considered useful for non-drought conditions. Increase irrigation efficiency by using mulch cover on the stack of grapes between the vine tress can be effective in coping with drought (Glynn, 2010; Feldmane, 2010). With efficient water consumption without any reduction in performance, you can limit the vegetative growth and reduce the cost of pruning. Different stages of grape growing have different sensitivity to drought. The vegetative bud break period until flowering have the best sensitive to drought and so should not use deficit irrigation at this period; because this step determines potential production of plants and 9% annual water requirement of plant at this stage is used.

From flowering until fruiting stages, drought stress can reduce fruiting and performance. The fruiting stage until beginning change in the color of fruit has least sensitive to the drought. In this stage with use the deficit irrigation techniques can reduce growth of plants without changing the yield quality and quantity. Irrigation water requirement for this period is 35% total annually water requirement. From beginning change in the color of fruit until harvest, sugar accumulation in fruit happened and minimum water requirement should provide for maintained a healthy leaves (Proffitt and Ward, 2009).
It is little information in Iran about vine response to soil moisture condition and the use of mulch in grapevine. Thus, the purpose of this study was to identify and assess effect of mulch and deficient irrigation on vine growth and yield until reach to a careful management in irrigation of vineyards in the years of low rainfall in order to minimize the damage.

MATERIALS AND METHODS

Experiment has done in a garden of one hectare vineyard (Vitis vinifera L.cv.Askari) in Torbate jam, khorasan, IRAN. Zone elevation is 960 meters with a loam soil texture. The experiment has done in randomized complete block design with 2 treatment and 4 repeat. The factors are amount of irrigation (supply 50%, 70%, 100% of plant water requirement) and use of mulch (with or without mulch). The amount of irrigation water consumption was 3600 m^3 for each tree during growing season. Deficit irrigation treatment was applied from beginning of fruit set until harvest (Campbell-Clause, 1990; Hardie and Martin, 1990)
To investigate the effect of different treatments on reproductive and vegetative traits of vine, various factors such as the branch length, number of main and auxiliary branches, weight of pruned branch, Number and weight of cluster, yield and Juice's brix level were examined. Statistical analyses were performed using MSTATC software. Analysis of variance, followed by planned comparisons, was used to test for differences among treatments

RESULTS AND DISCUSSION

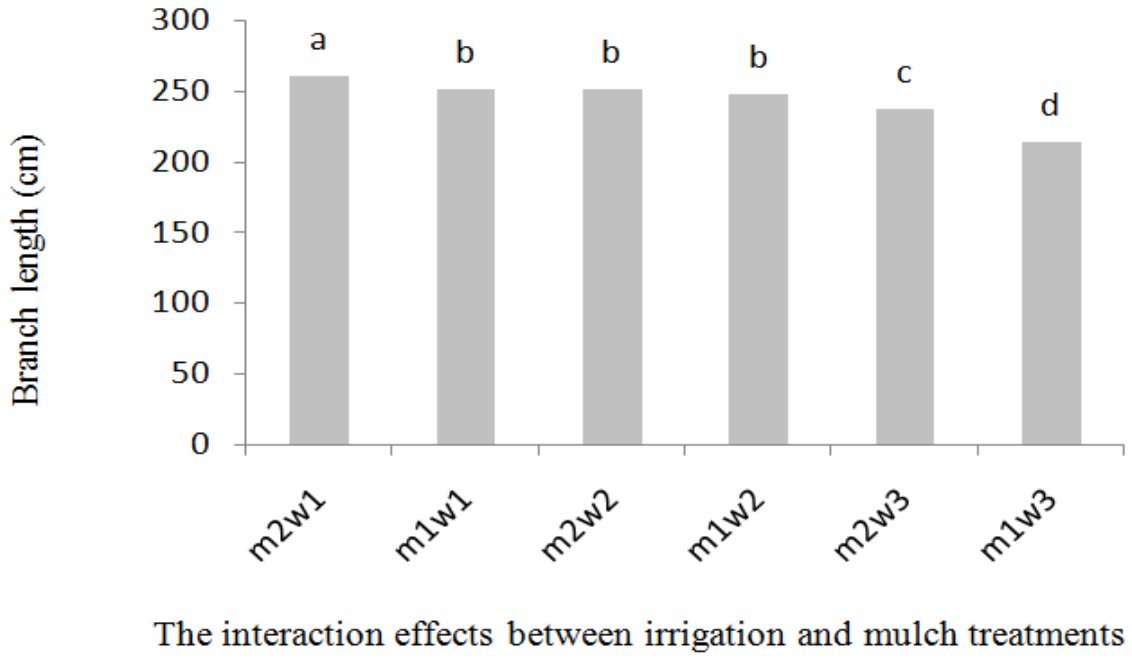

Figure 1: The interaction effects of different irrigation levels and mulch on branch length. m1w1 = no mulch + 100 % deficit irrigation, m1w2 = no mulch + 70% deficit irrigation, m1w3 = no mulch + 50% deficit irrigation, m2w1 = mulch + 100 % deficit irrigation, m2w2 = mulch + 70% deficit irrigation, m2w3 = mulch + 50% deficit irrigation

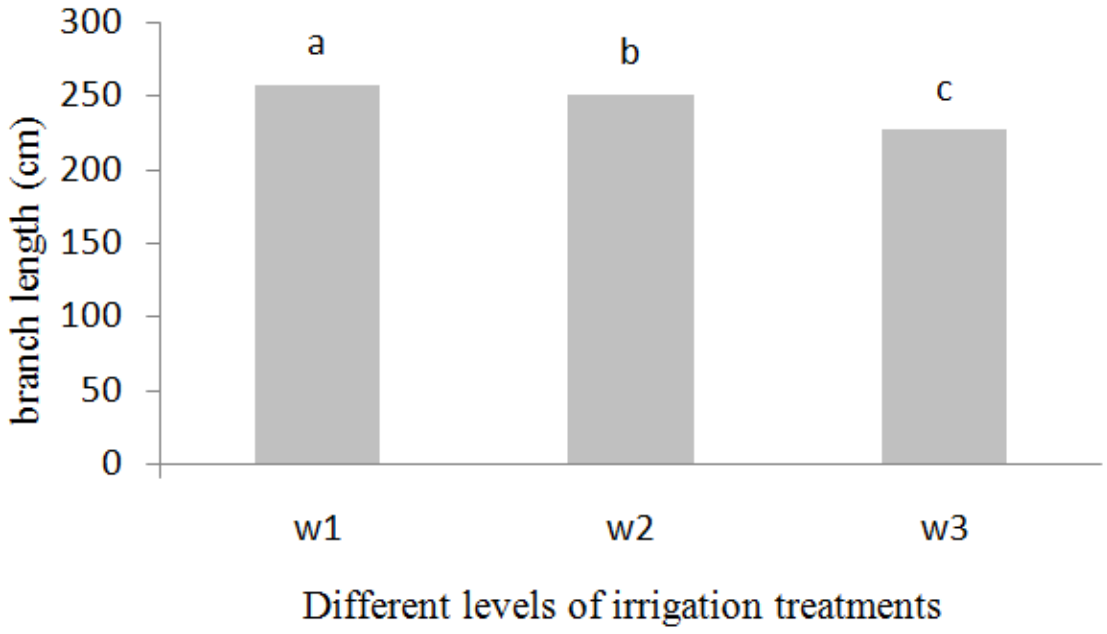

Figure 2: The effect of different irrigation levels on branch length. w1 = complete irrigation, w2 = 70% deficit irrigation, w3 = 50% deficit irrigation

Branches Length

The result has been showed that the interaction effect of different irrigation levels and mulch significantly reduced branch length of grape during growth season (Figure 1). Treatment mulch cover increased growth of branch that certainly was consequence of increasing soil moisture during growth season. It was observed that the maximum branches length is achieved at full irrigation and the minimum length obtained at 50% deficit irrigation (Figure 2).

McCarhty (1997a) showed that with applying 39 to 43% deficit irrigation in berry plants decreased 15% or 30% of grape branches length.

Effect of full irrigation treatment with use of mulch cover has the best branch growth. On the other hand, with decrease of irrigation without use mulch covers, the branch length decreased.

In figure 1, a significant difference is observed between treatment of full irrigation pluses mulch cover and other treatments, but no significant difference is observed between full irrigation and 70% deficit irrigation with or without mulch cover. No significant difference between these three treatments probably result from less effect of drought stress on branch growth during second period of grape growth (from fruit set until harvest) than first period of growth (Figure 1).

With decrease of amount of water even with mulch cover, branches length in grape decreased. The results has been shown that in treatments 50% deficient irrigation, branches growth reduction was more with mulch cover than with no mulch (Figure 1). This indicates that in severe drought stress, mulch cover has more effect for preservation plant vegetative growth.

The Number of Lateral Branches

The number of lateral branches on each plant was counted and analyzed. Effect of mulch and irrigation treatments was respectively significant at 1% and 5%. Interaction effect of irrigation and mulch cover was not significant. With comparison of different irrigation treatments data on number of auxiliary branch (Figure 3) we conclude that the most number of branch obtained from full irrigation treatment and the lest number of branch obtained from 50% deficit irrigation treatment. Albeit we see a little difference between 70% deficit irrigation and full irrigation and between 70% deficit irrigation and 50% treatment but these differences were not significant, which suggests that reduction the amount of water to a certain extent had not significant differences on the number of lateral branches.

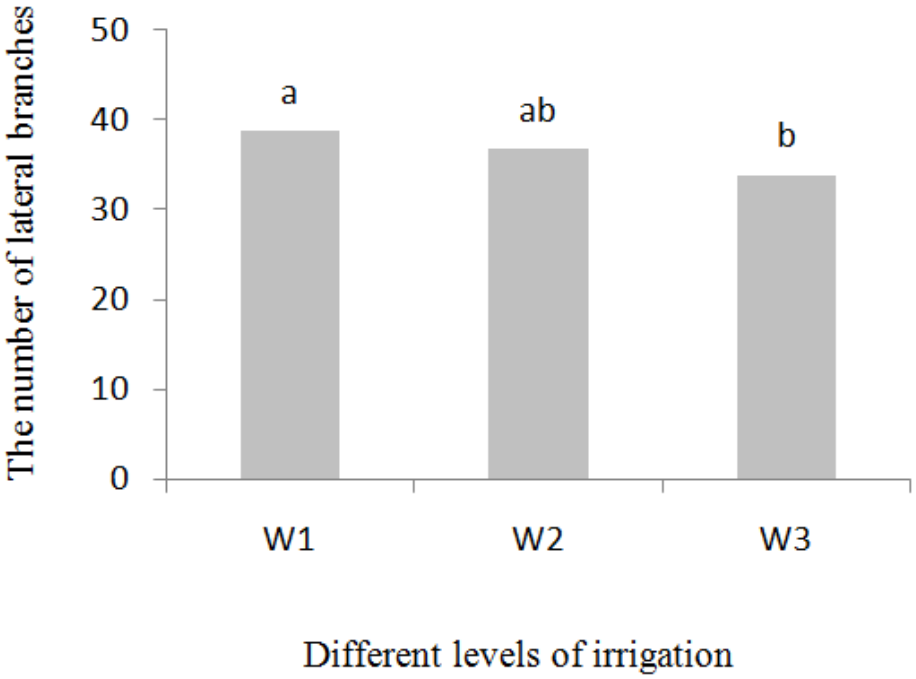

Figure 3: The effect of different irrigation levels on the number of lateral branches. w1 = complete irrigation, w2 = 70% deficit irrigation, w3 = 50% deficit irrigation

Weight of Pruned Branches

The weight average of pruned branches were measured and analyzed at end of the growing season. According to analysis of variance, effect of both treatments irrigation and mulch cover and also the interaction their effects were significant at 1%.

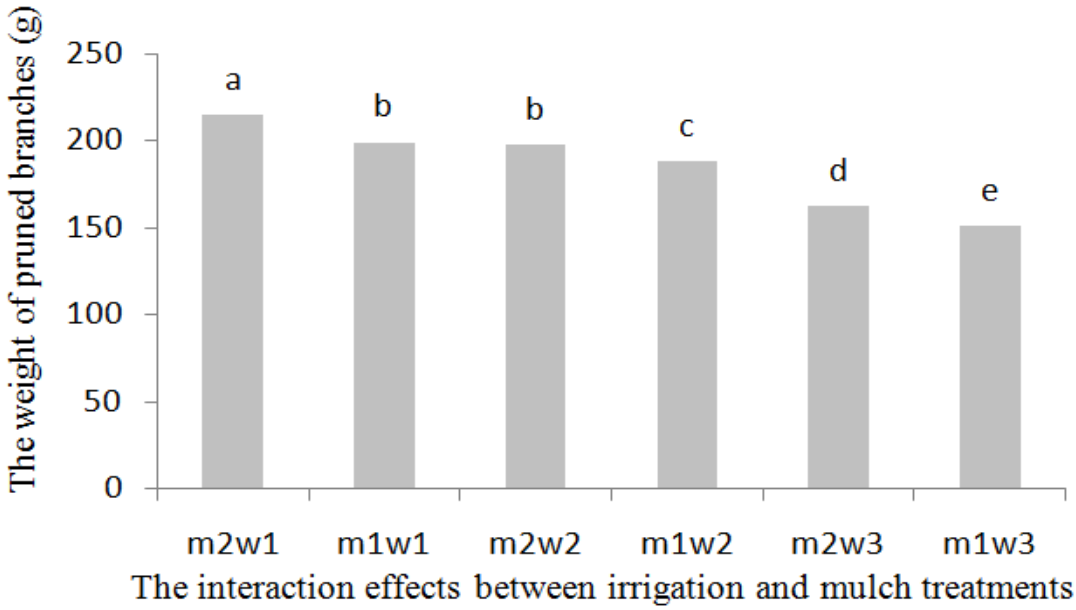

Figure 4: The interaction effects of different irrigation levels and mulch on pruned branches. m1w1 = no mulch + 100 % deficit irrigation, m1w2 = no mulch + 70% deficit irrigation, m1w3 = no mulch + 50% deficit irrigation, m2w1 = mulch + 100 % deficit irrigation, m2w2 = mulch + 70% deficit irrigation, m2w3 = mulch + 50% deficit irrigation

Mean comparison of irrigation treatments on pruned branches weight represents a significant reduction in the weight of pruned branches (Figure 4).
yhtraCcM (1997a) showed a 30% reduction in pruned branches weight of grape than full irrigation. Mean comparison of interaction effect of different irrigation level and mulch suggest that full irrigation treatment plus mulch cover have the most pruned branches and 50% percent irrigation without mulch cover have the lest weight of pruned branches (Figure 4).

With remove of mulch cover from full irrigation treatment, amount of pruned branches significantly reduced but no significant difference was observed between full irrigation without mulch cover and 70% irrigation with mulch cover; which reflects the effect of mulch cover on retention of soil moisture.

The significant differences between weights of pruned branches in different treatments suggest that difference in branches length induce difference in pruned branches weight.

Cluster Weight

The weight average of cluster per plant were measured and analyzed. According to analysis of variance, the effect of both irrigation and mulch cover treatments and also their interaction effects were significant at 1% (Figure 5 and 6).

According to the mean comparison chart, the most cluster weight related to full irrigation and with reduction in water consumption, cluster weight reduces. The results are consistent with the results of Chaves *et al.*, (2007).

According to the interaction effect of irrigation and mulch cover treatments on cluster weight, reduction of applied irrigation until 70% full irrigation have no significant effect on cluster weight but with sever deficit irrigation until 50% of full irrigation, clusters weight showed significant difference that with remove mulch cover this difference in cluster weight also increased.

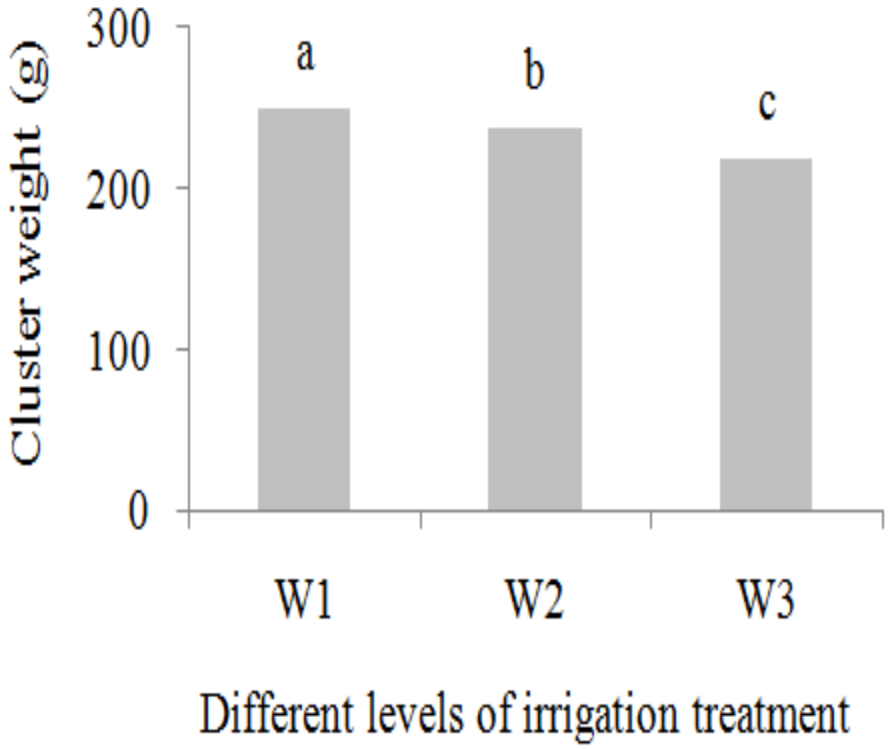

Figure 5: The effect of different irrigation levels on clusters weight. w1 = complete irrigation, w2 = 70% deficit irrigation, w3 = 50% deficit irrigation

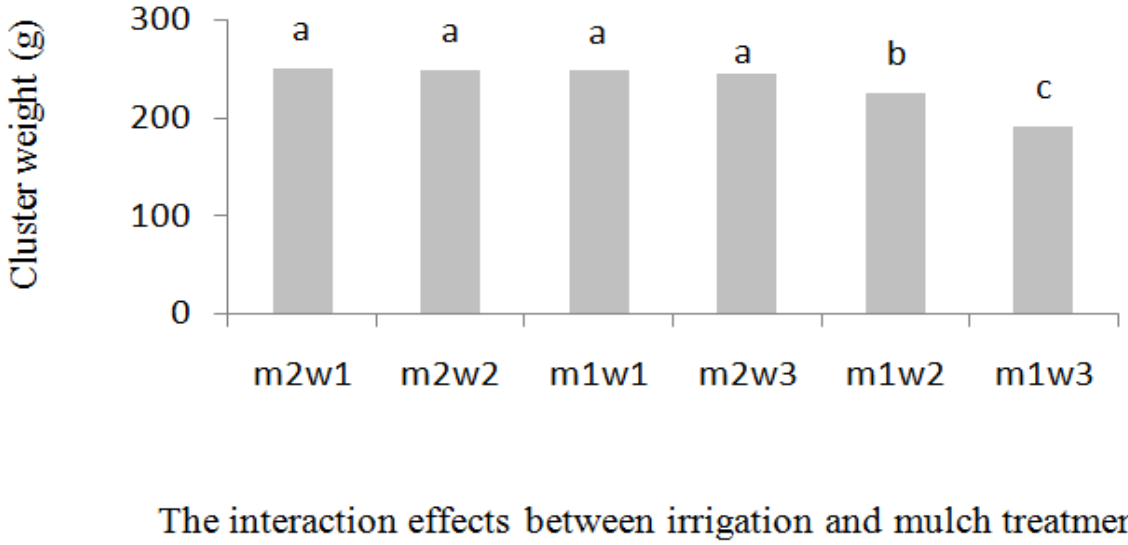

Figure 6: The interaction effects of different irrigation levels and mulch on clusters weight. m1w1 = no mulch + 100 % deficit irrigation, m1w2 = no mulch + 70% deficit irrigation, m1w3 = no mulch + 50% deficit irrigation, m2w1 = mulch + 100 % deficit irrigation, m2w2 = mulch + 70% deficit irrigation, m2w3 = mulch + 50% deficit irrigation

Number of Cluster per Plant

The number of cluster per plant was analyzed. According of variance analysis table, the effect of both irrigation and mulch treatments and also their interaction effects were significant at 1% and 5%; respectively. Mean comparison of irrigation treatments on cluster number per plant showed that with reduction in water consumption, cluster number decrease (Figure 7). The most and least number of clusters per plant obtained with full irrigation and with 50% of full irrigation; respectively.

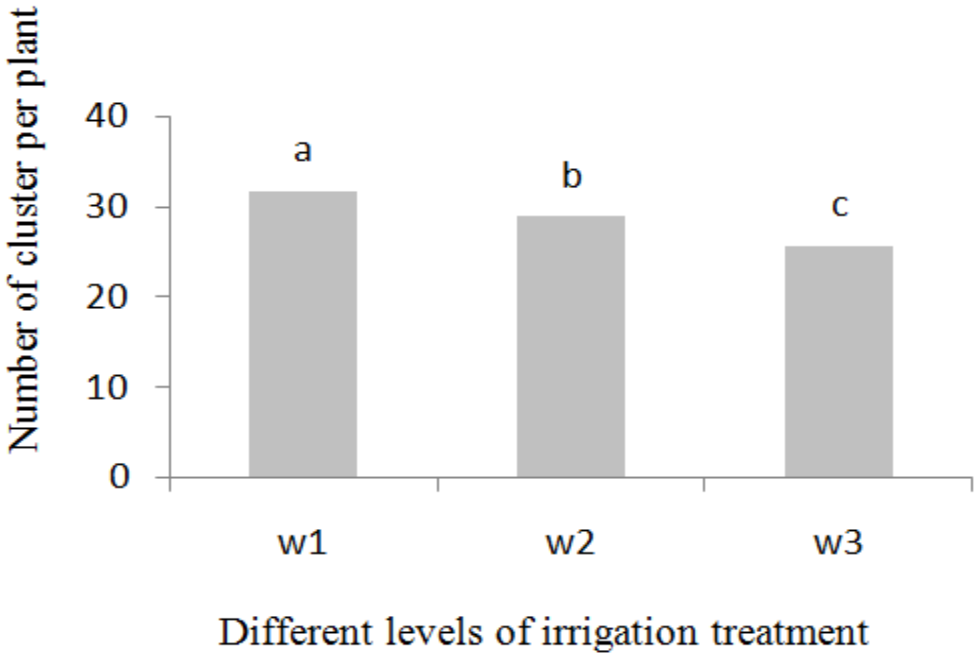

Figure 7: The effect of different irrigation levels on the number of clusters. w1 = complete irrigation, w2 = 70% deficit irrigation, w3 = 50% deficit irrigation

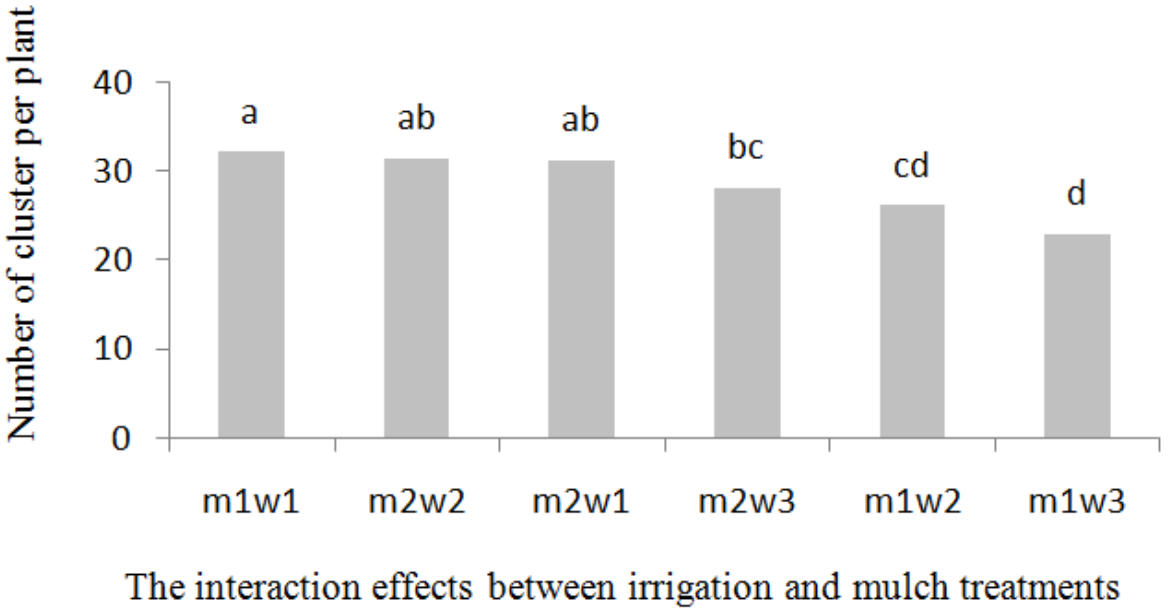

Figure 8: The interaction effects of different irrigation levels and mulch on the number of clusters. m1w1 = no mulch + 100 % deficit irrigation, m1w2 = no mulch + 70% deficit irrigation, m1w3 = no mulch + 50% deficit irrigation, m2w1 = mulch + 100 % deficit irrigation, m2w2 = mulch + 70% deficit irrigation, m2w3 = mulch + 50% deficit irrigation

According to analysis of variance, the most cluster number, respectively, related to full irrigation without mulch treatment, 70% full irrigation with mulch treatment and full irrigation with mulch treatment (Figure 8). Also, mulch cover + 50% of irrigation water compared to No mulch cover + 70% of irrigation water produced more number of clusters.

Yield

Analysis of variance showed that the effect of both irrigation and mulch treatments and also their interaction effects were significant at 1%.

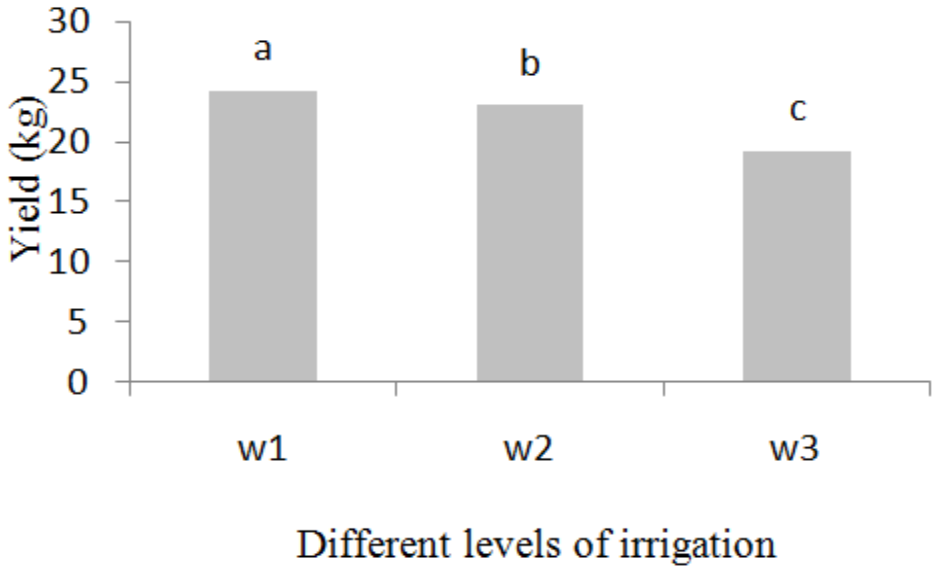

Figure 9: The effect of different irrigation levels on yield. w1 = complete irrigation, w2 = 70% deficit irrigation, w3 = 50% deficit irrigation

The comparison of data mean showed that the most yields were given by full irrigation. With reduction water consumption, yield reduced (Figure 9). It has been shown that because of mulch application, reducing of irrigation water until 50% of full irrigation had no effect on yield (Figure 10). But with reduction watering and remove the mulch cover, the performance is reduced. This result was corresponded with research of Bacon and Davies (2009) about peach and grape. Markus (2005), also, obtained similar result for deficit irrigation of grape.

This reduction in yield was due to the reduction in the number and weight of the cluster, because carbohydrates are translocated more towards vegetative buds and lead to excessive vegetative growth of plants.

Survey research conducted on effect of grape deficit irrigation like research conducted by Salon *et al.*, (2005) in Spain, also Hardie and Cosidine (1976) expressing the negative effect of deficit irrigation on berry size and yield. But on the other side, fruit quality factors like juice brix and color improved and fruit ripening also accelerate.

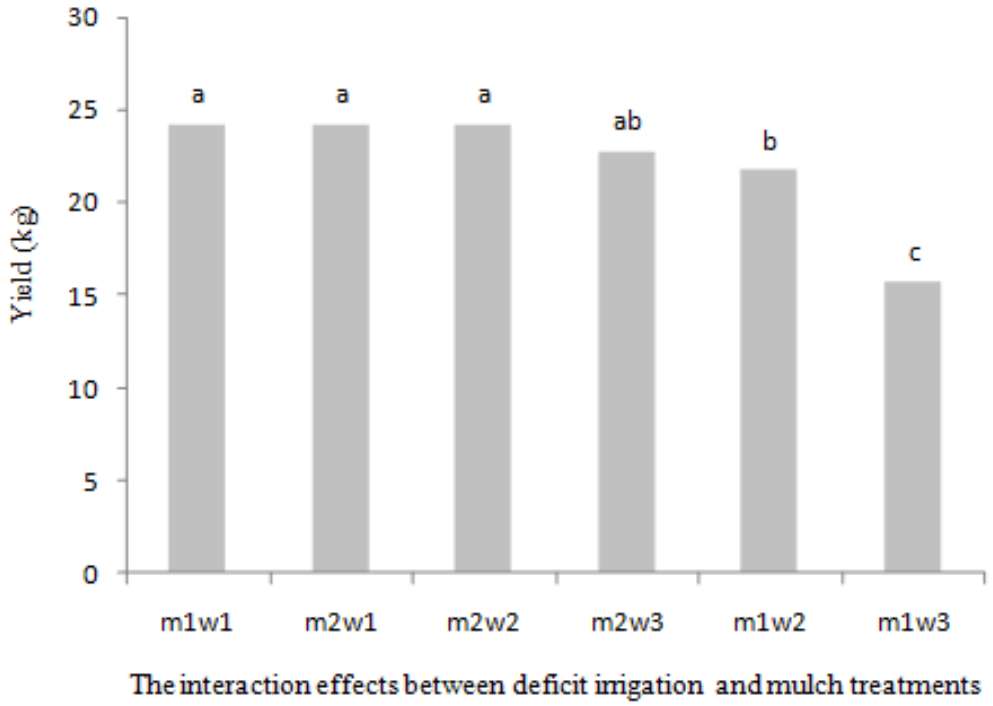

Figure 10: The interaction effects of different irrigation levels and mulch on yield. m1w1 = no mulch + 100 % deficit irrigation, m1w2 = no mulch + 70% deficit irrigation, m1w3 = no mulch + 50% deficit irrigation, m2w1 = mulch + 100 % deficit irrigation, m2w2 = mulch + 70% deficit irrigation, m2w3 = mulch + 50% deficit irrigation

Juice's Brix Level

According to analysis of variance, effect of mulch treatment on brix was significant at 1% level. Higher brix levels in mulch treatment than without mulch treatment is probably due to soil warmer and weakling bud earlier and increase growth season. It has been shown that with use of full irrigation in the first of growth period and regulated deficit irrigation in the second of growth period lead to increase in juice brix level (Girona *et al.*, 2006). Chaves *et al.*, (2007) suggested that increase of juice brix obtained from regular deficit irrigation is due to decrease in vegetative growth of branch and increase of light penetration to the tree canopy.

Conclusion

Results have been shown that use of mulch cover increase maintenance of soil moisture. In addition, increase the availability of water for plant roots resulting in increased vegetative growth. By reducing the amount of water, the factor as the number of lateral buds that affecting the growth are damaged and therefore result is reduction in vegetative growth (Leal, 2007; Proffitt and Campbel, 2011). Amount of water consumption and application of mulch cover affect grape productivity growth so that with decrease these treatments, the number and weight of cluster (yield) decrease.

This decrease of yield particularly in low level of water consumption was more indicators. In full irrigation treatment, application of mulch cover had no effect on increase yield, but led to increase storage of carbohydrate in vegetative meristem that increases vegetative growth and decrease yield (Proffitt and Campbel, 2011).

With mulch cover, the amount of juice brix raise that probably due to increase of plant vegetative growth because of soil warming and early start of vegetative growth in spring.

Today in some part of the world, application of deficit irrigation is a common operation, especially about red grape, because despite the possibility of reducing the rate of yield, increasing the quality of color and juice brix level can be compensated for the loss of yield (Giddings, 2001).

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