EFFECTS OF DIFFERENT VINEGAR TREATMENTS ON YIELD AND YIELD COMPONENTS OF FENUGREEK (*Trigonella foenum-graecum* L.) WITH LIMITED IRRIGATION CONDITIONS

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ABSTRACT
In this study, it was determined whether the treatment of red grape vinegar diluted at different rates on fenugreek (*Trigonella foenum-graecum* L.) plants grown in an environment where artificial drought conditions were created by limiting irrigation water would have an effect on the plant's adaptation to drought conditions and its effect on some yield and vegetative characteristics of the plant.
Irrigation water was given as unrestricted and 50% restricted, and concentration of red grape vinegar (control, 1% and 2%) were treated to the plants. The experiment was carried out according to the randomized block desing in split-split plots with three replicates. Irrigation application was placed in the main plot, fenugreek varieties were placed in the sub-plot, and vinegar treatments were placed in the bottom plot.
In the scope of the research; Characteristics such as plant height (cm), pod length (cm), number of pods per plant (pcs/plant), number of seeds per pod (pcs/pod), seed weight per plant (g/plant), thousand seed weight (g) were examined.
According to the results, while the effect of irrigation and vinegar treatments on plant height was observed, it was determined that there was no difference between the varieties. In irrigation applications, plant height was found to be 50.13 cm in applications with sufficient irrigation, while it was 31.21 cm in applications with limited irrigation. The effect of 2% vinegar treatment on plant height was negative. While the plant height in 2% vinegar treatments was 36.98 cm, the average plant height in control applications was 42.80 cm.
While the effect of irrigation and vinegar treatments on seed weight per plant was observed, no difference was observed between fenugreek varieties. In irrigation applications; Seed weight values per plant were determined as 2.88-1.22 g/plant in adequate irrigation and limited irrigation applications, respectively. The effect of 1% and 2% concentrations of vinegar treatments was greater than the control applications. In this application, seed weight per plant varied between 2,536-1,445 g.
As a result, it was determined that vinegar had a more positive effect on characteristics such as the number of seeds per pod and 1000 grains in fenugreek plants where irrigation water was limited. It would be beneficial to reveal these results more clearly through field trials.
Keywords: Drought, *Trigonella foenum-graecum*, Vinegar treatment, Yield

KISITLI SULAMA KOŞULLARINDA FARKLI ORANLARDAKİ SİRKE UYGULAMALARININ ÇEMEN (*Trigonella foenum-graecum* L.) BİTKİSİNDEKİ VERİM VE VERİM BİLEŞENLERİNE ETKİLERİ

ÖZET

Bu çalışma, sulama suyu kısıtlaması yapılarak suni kuraklık koşulları oluşturulan ortamda yetiştirilen, çemen (*Trigonella foenum-graecum* L.) bitkisinde farklı oranlarda seyreltilmiş kırmızı üzüm sirkesi uygulamasının bitkinin bu kurak koşullara uyum sağlamasında etkisinin olup olmayacağı ve bitkinin bazı verim ve bitkisel özellikleri üzerinde nasıl etkisi olduğu belirlenmeye çalışılmıştır.

Sulama suyu, kısıtlamasız ve %50 kısıtlı olacak şekilde uygulanmakla birlikte kırmızı üzüm sirkesi (kontrol, %1 ve %2'lik) konsantrasyonları bitkilere uygulanmıştır. Deneme tesadüf bloklarında bölünen bölünmüş parseller deneme desenine göre 3 tekerrürlü olarak yürütülmüştür. Ana parsele sulama uygulaması, alt parsele çemen çeşitleri, en alt parsele ise sirke uygulamaları yerleştirilmiştir.

Araştırma kapsamında; bitki boyu (cm), bakla uzunluğu (cm), bitki başına bakla sayısı (adet/bitki), bakladaki tohum sayısı (adet/bakla), bitki başına tohum ağırlığı (gr/bitki), 1000 tane ağırlığı (gr) gibi karakterlerde incelenmiştir.

Elde edilen sonuçlara göre bitki boyu üzerine sulama ve sirke uygulamaların etkisi görülürken, çeşitler arasında bir farkın olmadığı belirlenmiştir. Sulama uygulamalarında bitki boyu, yeterli sulama yapılan uygulamalarda 50.13 cm iken, kısıtlı sulama yapılan uygulamalarda 31,21 cm olarak bulunmuştur. Sirke uygulamalarının bitki boyu üzerinde %2'lik konsantrasyonunun etkisi olumsuz olmuştur %2'lik uygulamalarda bitki boyu 36.98 cm iken kontrol uygulamalarında ortalama bitki boyu 42,80 cm olarak bulunmuştur.

Bitki başına tohum ağırlığı üzerine sulama ve sirke uygulamaların etkisi görülürken, çemen çeşitleri arasında bir fark ortaya çıkmamıştır. Sulama uygulamalarında; bitki başına tohum ağırlığı değerleri, yeterli sulama ile kısıtlı sulama uygulamalarında sırasıyla 2,88-1,22gr/bitki olarak tespit edilmiştir. Sirke uygulamalarının ise %1'lik ve %2'lik konsantrasyonlarının etkisi kontrol uygulamalarına göre daha fazla olmuştur. Bu uygulamada da bitki başına tohum ağırlığı 2,536-1,445 gr arasında değişmiştir.

Sonuç olarak, sulama suyu kısıtlaması yapılan durumlarda, sirke uygulamasının çemen bitkisinde, bakladaki tohum sayısı, bin dane ağırlığı gibi özelliklerine daha olumlu etki yaptığı belirlenmiştir. Bu sonuçların tarla denemeleriyle çok daha net şekilde ortaya konulması faydalı olacaktır.

Anahtar Kelimeler: Kuraklık, Sirke Uygulaması, *Trigonella foenum-graecum*, Verim

INTRODUCTION

Fenugreek is a spice as well as a legume crop. It is an annual herbaceous and autogamous crop in the Fabaceae family and the Papillionaceae subfamily. There are three ways to utilize fenugreek in culinary; as a vegetable (fresh leaves, sprouts, and microgreens), as a spice (seeds), or as a herb (dried or fresh leaves). Its seeds are used as a concentrate for cattle as well as a spice and vegetable for human consumption. Pickles, vegetable dishes, daals, and spice blends like sambar powder are all made with the seeds. Fenugreek seeds are used whole or powdered, and they are frequently roasted to bring out the flavor and lessen the bitterness. Because of the presence of alkaloids known as "trigonellin," which is regarded a fundamental ingredient for the creation of cellulose, hemicellulose, nutrients, and amino acids, the seed has a bitter flavor. It reduces constipation, relieves indigestion, stimulates the spleen and liver, and is diuretic and tasty. It is used in several Ayurvedic remedies for caliclactylence, dysentery, diarrhea, and dyspepsia with loss of appetite (particularly for gastrointestinal problems).

Argentina, Egypt, France, Spain, Turkey, Morocco, Pakistan, India, Iran, Nepal, Bangladesh, and Morocco are the main producers of fenugreek. India is the world's biggest fenugreek producer. (Meena et al., 2017).

Inadequate irrigation scheduling frequently results in lower agricultural yields. In regions where water resources are inexpensive, abundant, and guaranteed throughout the growing season, it would be feasible to plan irrigation as needed to ensure crops receive all the water they require to reach their full potential. However, insufficient rainfall, the growth of cultivated areas, and inadequate groundwater recharge particularly in arid and semi-arid regions have made water supplies limited in several parts of the world in recent years. In such regions, the most effective plan of action would be to irrigate the maximum area at a reduced intensity rather than a large area intensively. This would increase overall production and irrigation water use efficiency, both of which can be ensured by irrigating the crop at critical phenological growth stages. Water is a valuable resource, hence research on irrigation timing, water consumption efficiency, and soil moisture distribution patterns is directly relevant to increasing agricultural yields (Singh et al. 2005). Under restricted water supply, a pressurized irrigation system has been proven to be highly successful not only in generating increased production but also in economizing other inputs such as fertilizers, pesticides, labor, and so on.

Plants subjected to water limitation frequently exhibit disrupted physiology and metabolic abnormalities such as cell shrinkage, loss of cell turgor, restricted water absorption, decreased photosynthetic capability, nutritional imbalance, and over-accumulation of reactive oxygen species (ROS) (Choudhury et al. 2017, Dubey et al. 2018, Liang et al. 2018, Tardieu et al. 2018, Yang et al. 2019). Exogenous acetic acid (AA) or acetate treatments have recently been well-documented for the reduction of several abiotic stressors, including drought. Importantly, the role of acetic acid (AA) in drought tolerance mechanisms such as improved water usage efficiency, osmoprotective acquisition, nutritional intake, and ROS-detoxification via antioxidant defense systems is still poorly known (Rahman et al., 2021). Acetic acid pretreatment improved abiotic stress tolerance in several crops, including soybean (*Glycine max*), apple (*Malus domestica*), cassava (*Manihot esculenta*), rice (*Oryza sativa*), wheat (*Triticum aestivum*), maize (Zea mays), rapeseed (*Brassica napus*), salt stress in mung beans (*Vigna radiata*), and copper stress in lentils (*Lens culinaris*) according to earlier studies (Kim et al. 2017; Utsumi et al. 2019; Rahman et al. 2019, 2021; Hossain et al. 2020)

Grape vinegar is a fermentation product that can be obtained in a variety of ways. Through acetic acid fermentation, alcohol is converted into acetic acid during this fermentation process. According to a study, acetic acid content of some grape vinegars produced in Turkey were found to be between 3.56-5.21 g/100 mL which is suitable with Turkish Food Codex (TS 1880 EN 13188) (Akbaş and Cabaroğlu, 2010). Due to these properties, grape vinegar can be used against drought stress in plants due to its rich acetic acid content. This study was caried out to determine the effect of red grape vinegar treatments on the yield and some agricultural characteristics of fenugreek (*Trigonella foenum-graecum* L.) some cultivar and population under the limited irrigation conditions.

MATERIALS AND METHODS

Gürarslan cultivar of fenugreek plant and a population variety obtained from Denizli province were used as material. Irrigation water was given unrestricted and 50% limited. Control, 1% and 2% diluted concentrations of red grape vinegar (pH 1.2) produced by organic production methods (Sarıgöl grape producers agricultural development cooperative) were applied exogenously to the plants. While these concentrations of 100 ml of vinegar concentrations (1ml/100 ml and 2ml/100ml) were applied to each pot, only distilated water was applied for the control groups. The experiment was carried out according to the randomized block design in split-split plots with three replicates.

Irrigation application was placed in the main plot, fenugreek varieties were placed in the sub-plot, and vinegar treatments were placed in the bottom plot. Tensiometer, which shows the moisture content of the soil, was used to determine the irrigation needs of the plants. After grape vinegar was applied to the plants, the irrigation time for all plants was determined by a tensiometer. While one group of plants was treated with irrigation water (500 ml) for each pot (at a sufficient level), the other group of plants was given limited irrigation by giving 250 ml of water each time, 50% less than the amount given to the first group. An artificial drought stress was created on plants that received limited irrigation.

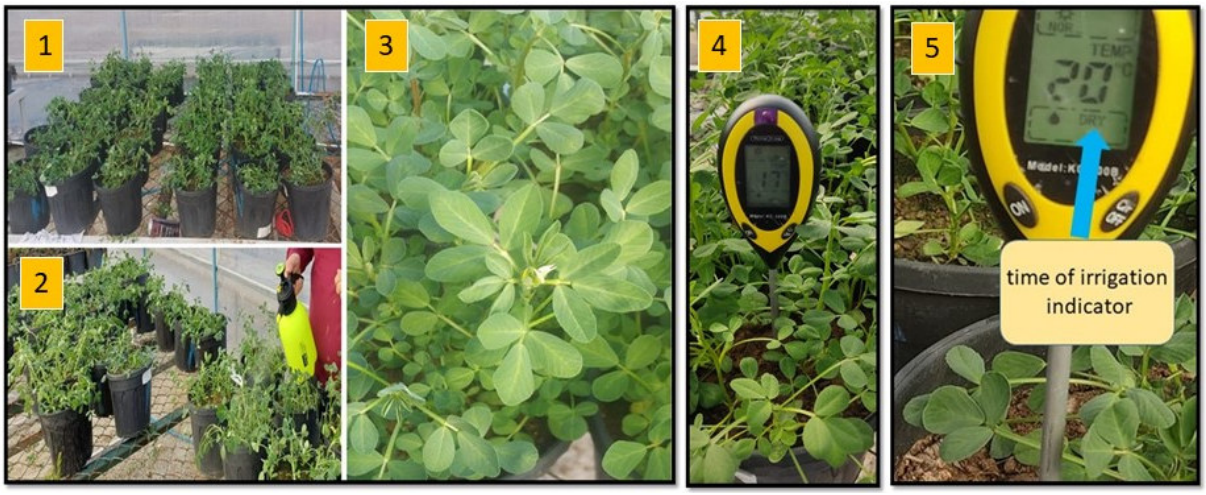


Figure 1. Cultivation of plants before vinegar treatment (1), Vinegar treatment (2), Beginning of flowering (3), Determination of irrigation needs of plants with tensiometer (4,5)

In the measurements made throughout the experiment, irrigation was carried out a total of 12 times. Thus, in applications without irrigation limitation, a total of 12 x 500 ml = 6 liters of water was applied for each pot, and for applications with 50% water limitation, 12 x 250 ml: 3 liters of water was applied. In the experiment, pots with a diameter of 16 cm and a height of 15 cm were used. Since the calculation is made based on the pot area [3,14 x (8cm) ^{2} =200,96cm^2 =0,02m^2], in applications without irrigation limitation, when 6 liters of water are consumed for each pot with a total area of 0.02 m², it is seen that a total of 300 kg/m² of water is applied to 1 m² area. In applications with water limitation, half of this amount, 150 kg/m² of water, was applied (Figure 1).

In the scope of the research; Characteristics such as plant height (cm), pod length (cm), number of pods per plant (pcs/plant), number of seeds per pod (pcs/pod), seed weight per plant (g/plant), thousand seed weight (g) were examined.

Variance analysis of the average values of the characters measured in the experiment was performed in the Mstat-C package program and the differences between the averages were determined with the Duncan test.

RESULTS AND CONCLUSIONS

Plant Height

As a result of the variance analysis of the average values of plant height, it was determined that irrigation and vinegar treatments were significant at the $p<0.01$ level.

In terms of vinegar concentrations, the highest plant height (42.80 cm) was obtained from the control application, and the lowest was obtained from the 2% vinegar application (36.98 cm). The difference between the control application and the applications with 1% vinegar application was not found to be statistically significant.

In different irrigation applications, the highest plant height of 50.13 cm was obtained from applications without water restriction, while the lowest plant height was obtained from the irrigation application with 50% water limitation (31.21 cm). This situation is expected, water positively affected the development of plants.
Intraction values between irrigation and vinegar concentration applications were found to be significant at $p<0.05$. The highest (50.40 cm) was obtained from the control application of vinegar concentrations with adequate irrigation. The lowest (26.57cm) was obtained from plants with limited irrigation and 2% vinegar application.
Several researchers reported that plant height of fenureek were found to be 48.50-57.50 cm (Bozdemir et al., 2016), 32.43-43.73 cm (Özel et al., 2008) and 48.22-50.96 cm (Beyzi, 2011). Our control group with sufficient irrigation conditions confirms these results.

Table 1. Effects of different irrigation applications and vinegar treatments on plant height (cm) of *Trigonella foenum-graecum*

Plant height	***Irrigation types (a)***	***Cultivar (b)***	***Vinegar treatment rates (c) axbxc interaction *****			***Irrigation types *****	**axc *interaction* ***	*Control*	*1%*	*2%*
			Control	*1%*	*2%*	*means*	*Sufficient irrigation*	***50,40 ab***	***52,60 a***	***47,40 b***
	Sufficient irrigation	*Denizli*	*48,67*	*50,27*	*47,60*	***50,13 a***	*Limited irrigation*	***35,20 c***	***31,87 c***	***26,57 d***
		Güraslan	*52,13*	*54,93*	*47,20*		**bxc *interaction* ns**	*Control*	*1%*	*2%*
	Limited irrigation	*Denizli*	*35,00*	*28,67*	*25,33*	***31,21 b***	*Denizli*	*41,83*	*39,47*	*36,47*
		Güraslan	*35,40*	*35,07*	*27,80*		*Güraslan*	43,77	45,00	37,50
	Vinegar treatment **	***General means***	*Control*	*1%*	*2%*		***axb interaction ns***	*Denizli*		*Güraslan*
			42,80 a	***42,23 a***	***36,98b***		*Sufficient irrigation*	***48,84***		***51,42***
	Cultivars ns	***General means***	*Denizli* ***39,26***		*Güraslan* ***42,09***		*Limited irrigation*	***29,67***		**32,76**

**** is significant p<0.01, * is significant p<0.05, ns: non-significant; CV: % 5,73**

Triple interaction values were not found to be statistically significant, however, the maximum plant height was observed on Gürarslan cultivar (54,93 cm) with sufficient irrigation condition treated with contentration of 1% vinegar. This was followed by with the same cultivar on the same irrigation conditions without vinegar treatment (52,13cm). Gürarslan cultivar displayed higher plant height compared to Denizli population. Gürarslan cultivar responded better vinegar treatment in limited irrigation conditionds compared to population variety (Table 1.)

Pod Lenght

As a result of the variance analysis of the average values of pod length, it was determined that none of the applications and the differences between the double and triple interaction values between these applications were statistically significant.
According to the triple interaction values, pod length varied between 5.05-8.53cm. Pod lenght in each treatment and application was found smaller compated to some studies (Meena et al., 2017; Köroğlu, 1985) which is highly dependent on environment, cultivar, climate etc.

Table 2. Effects of different irrigation applications and vinegar treatments on pod lenght (cm) of *Trigonella foenum-graecum*

Pod Lenght	***Irrigation types (a)***	***Cultivar (b)***	***Vinegar treatment rates* (c) axbxc interaction ns**			***Irrigation types* ns**	**axc *interaction* ns**	*Control*	*1%*	*2%*
			Control	*1%*	*2%*	*means*	*Sufficient irrigation*	***7,86***	***7,84***	***7,65***
	Sufficient irrigation	*Denizli*	*7,18*	*7,23*	*7,57*	***7,78***	*Limited irrigation*	***6,63***	***6,04***	***5,36***
		Güraslan	*8,53*	*8,45*	*7,72*		**bxc *interaction ns***	*Control*	*1%*	*2%*
	Limited irrigation	*Denizli*	*7,07*	*5,8*	*5,67*		*Denizli*	***7,12***	***6,52***	***6,62***
		Güraslan	*6,20*	*6,29*	*5,05*	***6,01***	*Güraslan*	**7,37**	**7,37**	**6,39**
	***Vinegar treatment* ns**	***General means***	*Control*	*1%*	*2%*		***axb* interaction ns**	*Denizli*		*Güraslan*
			7,25	***6,94***	***6,50***		*Sufficient irrigation*	***7,32***		***8,23***
	Cultivars ns	***General means***	*Denizli*		*Güraslan*		*Limited irrigation*	***6,18***		**5,85**
			6,75		***7,04***					

**** is significant p<0.01, * is significant p<0.05, ns: non-significant; CV: % 11,12**

Number of Pods Per Plant

As a result of the variance analysis of the average values of the number of pods per plant, irrigation application and vinegar concentrations were found to be statistically significant at the p<0.01 level. While 7.24 pods/plant were formed in applications without irrigation limitations, an average of 4.17 pods/plant were obtained in applications with limited irrigation.

In terms of vinegar treatments, the highest number of pods (6.43 units/plant) was obtained at a 1% concentration of vinegar treatment, while the lowest was obtained from the control group with 4.73 units/plant. According to these results, it was determined that vinegar treatment increased the number of pods per plant (Table 3).

The differences between the other applications and the double and triple interaction values between these applications were not found to be statistically significant.

According to the triple interaction values, the average number of pods varied between 8.97-3.27 units/plant.

Also, number of pods per plant, generally, found lower than field studies (Meena et al., 2017; Bozdemir et al., 2016).

Table 3. Effects of different irrigation applications and vinegar treatments on number of pods per plant of *Trigonella foenum-graecum*

Number of Pods per Plant	***Irrigation types (a)***	***Cultivar (b)***	***Vinegar treatment rates* (c) axbxc interaction ns**			***Irrigation types* ****	**axc *interaction* ns**	*Control*	*1%*	*2%*
			Control	*1%*	*2%*	*means*	*Sufficient irrigation*	***5,87***	***8,15***	***7,70***
	Sufficient irrigation	*Denizli*	*5,60*	*8,97*	*8,20*	***7,24 a***	*Limited irrigation*	***3,60***	***4,70***	***4,22***
		Güraslan	*6,13*	*7,33*	*7,20*		**bxc *interaction* ns**	*Control*	*1%*	*2%*
	Limited irrigation	*Denizli*	*3,27*	*4,93*	*4,77*	***4,17 b***	*Denizli*	***4,43***	***6,95***	***6,48***
		Güraslan	*3,93*	*4,47*	*3,67*		*Güraslan*	***5,03***	***5,90***	***5,43***
	Vinegar treatment **	***General means***	*Control*	*1%*	*2%*		***axb interaction ns***	*Denizli*		*Güraslan*
			4,73 b	***6,43 a***	***5,96 a***		*Sufficient irrigation*	***7,59***		***6,89***
	Cultivars ns	***General means***	*Denizli*		*Güraslan*		*Limited irrigation*	***6,18***		***4,32***
			6,75		***7,04***					

**** is significant p<0.01, * is significant p<0.05, ns: non-significant; CV: % 15,42**

Seed Numbers Per Pod

As a result of the variance analysis of the average values of the number of seeds in the broad bean, irrigation application and vinegar concentrations were found to be statistically significant at the p<0.01 level. While the number of seeds per pod was 25.42 in applications without irrigation limitation, 19.23 seeds were obtained in applications with limited irrigation. In vinegar treatments, the highest number of seeds per pod (24.06 pieces/pod) was obtained at 2% vinegar concentration, while the lowest was obtained from the control group with 19.77 pieces/pod.

The difference between the binary interaction values of irrigation x vinegar concentrations was significant at the p<0.01 level. The highest number of seeds, 27.32, was obtained from the application of 1% vinegar concentration without irrigation limitation. The lowest number of seeds per pod was obtained from the control application of vinegar concentrations with limited irrigation of 15.35. These results are in agreement with Bazzazi et al., (2013). Also, it was determined that vinegar application increased the number of seeds in the pod. Under limited irrigation conditions, 2% vinegar application was statistically in the same group with the highest average values obtained from applications without irrigation limitation.

The differences between the other applications and the double and triple interaction values between these applications were not found to be statistically significant.

According to the triple interaction values, the average number of pods varied between 14.33-27.46 units/pod (Table 4).

Table 4. Effects of different irrigation applications and vinegar treatments on seed numbers per pod of *Trigonella foenum-graecum*

Number of Pods per Plant	*Irrigation types (a)*	*Cultivar (b)*	*Vinegar treatment rates* (c) axbxc interaction ns			*Irrigation types* *	axc *interaction* **	*Control*	*1%*	*2%*
			Control	*1%*	*2%*	*means*	*Sufficient irrigation*	***24,19 a***	***27,32 a***	***24,75 a***
	Sufficient irrigation	*Denizli*	*25,53*	*27,18*	*24,10*		*Limited irrigation*	***15,35 b***	***18,98 b***	***23,37 a***
		Güraslan	*22,85*	*27,46*	*25,41*	***25,42 a***	**bxc *interaction ns***	*Control*	*1%*	*2%*
	Limited irrigation	*Denizli*	*16,37*	*19,50*	*22,46*		*Denizli*	***20,95***	***23,34***	***23,28***
		Güraslan	*14,33*	*18,45*	*24,29*	***19,23 b***	*Güraslan*	***18,59***	***22,96***	***24,85***
	Vinegar treatment **	***General means***	*Control*	*1%*	*2%*		***axb interaction ns***	*Denizli*		*Güraslan*
			19,77 b	***23,15 a***	***24,06 a***		*Sufficient irrigation*	***25,60***		***25,24***
	Cultivars ns	***General means***	*Denizli*		*Güraslan*		*Limited irrigation*	***6,18***		***19,44***
			22,52		***22,13***					

**** is significant p<0.01, * is significant p<0.05, ns: non-significant; CV: % 10,20**

Thousand Seed Weight

As a result of the variance analysis of the average values of thousand seed weights, it was found that the vinegar treatments were statistically significant at the p < 0.01 level, while the difference between the irrigation application and the general average values of the varieties was statistically insignificant..

While the highest thousand seed weight (17.15 g) was obtained in 1% vinegar treatments, the average value of the control group (15.75 g) was observed to be in the same group. The lowest thousand seed weight was obtained from the treatments of 2% vinegar concentration (14.01 g).

The difference between the binary interaction values of irrigation × vinegar concentrations was significant at the p<0.01 level. The weight of thousand seed weight was 18.88 g, obtained from the application of 1% vinegar concentration with irrigation limitation. The lowest was obtained from the treatment of 2% vinegar concentration with limited irrigation of 10.54 g. These results are in agreement with Chauhan et al., (2017). It was determined that vinegar treatment increased the thousand seed weight, but its 2% concentration decreased it.

The difference between the binary interaction values of the cultivar and vinegar concentration treatments was found to be significant at the p<0.01 level. The highest thousand seed weight was 18.74 g, obtained from the treatments where 1% vinegar was applied to the Güraslan cultivar. The lowest amount was 12.17 g from the treatment of 2% vinegar to the Denizli population.

According to the triple interaction values, the differences between the mean values were found to be significant at the 1% level. The highest thousand seed weight was 20.40 g, obtained from the control group of vinegar concentrations in plants belonging to the Denizli population, where limited irrigation was applied. It was determined that Gürsaslan cultivar, which is statistically in the same group with these values, was 20.37 g in limited irrigation with 1% vinegar treatment. The lowest amount was 7.85 g from 2% vinegar treatment in the Denizli population with limited irrigation. (Table 5).

Table 5. Effects of different irrigation applications and vinegar treatments on thousand seed weight of *Trigonella foenum-graecum*

Number of Pods per Plant											
	Irrigation types (a)	***Cultivar (b)***	***Vinegar treatment rates* (c) axbxc interaction ****			***Irrigation types* ns**	**axc *interaction* ****	*Control*	*1%*	*2%*
			Control	*1%*	*2%*	*means*	*Sufficient irrigation*	*13,57 c*	*15,42 bc*	*17,48 ab*
	Sufficient irrigation	*Denizli*	*12,88e*	*13,73de*	*16,49b-e*	*15,49*	*Limited irrigation*	*17,93 a*	*18,88 a*	*10,54 d*
		Gürarslan	*14,26c-e*	*17,11a-d*	*18,48ab*		**bxc *interaction* ****	*Control*	*1%*	*2%*
	Limited irrigation	*Denizli*	*20,40a*	*17,38 abc*	*7,85f*		*Denizli*	*16,64 ab*	*15,56 b*	*12,17 c*
		Gürarslan	*15,46b-e*	*20,37a*	*13,23e*	*15,78*	*Gürarslan*	*14,86 b*	*18,74 a*	*15,85 b*
	Vinegar treatment **	***General means***	*Control*	*1%*	*2%*		***axb interaction ns***	*Denizli*		*Gürarslan*
			15,75 a	*17,15 a*	*14,01 b*		*Sufficient irrigation*	*14,36*		*16,62*
	Cultivars ns	***General means***	*Denizli*		*Güraslan*		*Limited irrigation*	*6,18*		*15,21*
			14,79		*16,49*					

**** is significant p<0.01, * is significant p<0.05, ns: non-significant; CV: % 8,78**

CONCLUSION

In conclusion, it was determined that 1% concentrations of vinegar treatment positively affected characteristics such as plant height, number of pods, number of seeds in the pod, and thousand-seed weight. However, it has been observed that some of these characters are negatively affected at higher concentrations of vinegar (2%). It has been determined that by applying vinegar exogenously to the plant in arid conditions with water constraints, under conditions of limited irrigation, the yield and yield characteristics can be obtained as much as the applications under normal conditions, that is, with adequate irrigation. As a result, it was determined that vinegar had a more positive effect on characteristics such as the number of seeds per pod and 1000 grains in fenugreek plants where irrigation water was limited. It would be beneficial to reveal these results more clearly through field trials.

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