INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
Volume-4, Issue-2, April-June-2014
ISSN 2231-4490
Coden : IJPAES www.ijpaes.com

Received: 24th Feb-2014 *Revised: 15th March-2014* *Accepted: 20th March-2014*
Research article

INFLUENCE OF WATER DEFICIT ON SEED YIELD AND ESSENTIAL OIL CONTENT OF DILL *(Anithum graveolens* L.*)*

Nahid Niari Khamssi

Department of Agronomy and Plant Breeding, Faculty of Engineering, Islamic Azad University, Kermanshah Branch, Iran
∗ Corresponding author: *E-mail: khamssi@gmail.com, nniari@iauksh.ac.ir*

ABSTRACT: Anethum graveolens Linn. (Umbelliferae, A. graveolens) is a widely used spice with a long history of traditional medicinal use for the treatment of various ailments. The biosynthesis of secondary metabolites in medicinal and aromatic plants is affected by abiotic stresses such as water deficit. This study was carried out to evaluate seed yield and essential oil of dill under five irrigation disruption treatments at different growth stages. Four irrigation treatments were consisted of irrigation disruption during stem elongation (I_1), irrigation disruption during umbel emergence and grain filling (I_2), irrigation disruption during umbel emergence (I_3), irrigation disruption during grain filling (I_4) and well watered treatment (I_5). Results showed that the different irrigation treatments had no considerable effect on grain yield of dill. The highest and lowest essential oil content was obtained under I_1 and I_5 treatments, respectively. It seems that the essential oil content of dill can be increased partly by a moderate water deficit during vegetative stage (stem elongation).
Key words: Dill, essential oil content, water deficit, yield

INTRODUCTION

Cardiovascular disease, currently the leading cause of death and illness in developed countries, will soon become the pre-eminent health problem worldwide [1,2]. Efforts to develop effective and better hypo-lipidaemic drugs have led to the discovery of natural agents. Research in herbal medicine has increased in the world as an alternative solution to health problems. Many plant extracts have been shown to have hypo-cholesterolemic activity in rats and the effects of several extracts have been described [3,4]. *Anethum graveolens* L. (Umbilliferae), known as dill, is an annual herb growing in the Mediterranean region, Europe, central, southern Asia and it is widely cultured in south eastern region of Iran. The plant is used both medicinally and as an aromatic herb and spice and cookery [5]. Dill is used as an aromatic vegetable, a carminative, and an antispasmodic.

Stress is known to induce alterations in various physiological responses, leading to a pathological state. Stress causes disturbance in the body's normal physiological equilibrium and results in threatened homeostasis [6]. Every human today faces stressful situations in day-to-day life and overstress has been postulated to be involved in the pathogenesis of a variety of diseases, such as depression and anxiety, immunosupression, endocrine disorder including diabetes mellitus, male sexual disfunction, cognitive dysfunction, peptic ulcers, hypertension and ulcerative colitis [7]. There is increasing evidence that severe stress affects cognitive functions and leads to the pathogenesis of various neurodegenerative disorders such as Alzheimer's disease, Parkinson's disease and aging [8,9]. Spices, widely recognized as food additives have been used traditionally to prevent and treat various diseases. *Anethum graveolens* Linn. (Umbelliferae), is a popular aromatic herb in Indian, African, Chinese, Cuban, Iranian and Mexican cuisines. As a folk remedy, *A. graveolens* is used for some gastrointestinal ailments such as flatulence, indigestion, stomach ache and colic [10]. In a large part of the agricultural areas in the world, water is an important factor limiting growth and productivity. An efficient use of scarcely available water and good productivity under poor water supply are desirable for crops in west Asia [11]. Since water resources in north-west of Iran are limited at the later stages of dill growth and development, this research was aimed to investigate the influence of disruption of irrigation at different stages of growth on the seed yield and essential oil of dill.

MATERIALS AND METHODS

Site Description and Plant Material:

The experiment was carried out in 2011 at the Research Farm of Kermanshah Azad University (latitude 34º20' N, longtitude 46º20' E, altitude 1351.6 m above sea level). Kermanshah is located in west of Iran and has a mean annual temperature of 13.8ºC and annual rainfall of 478 mm. The soil texture of the research area was sandy-loam.

Experimental Procedure

The experiment was performed based on randomized complete block design with three replications. Every replication had 5 plots with 3 × 1.5 m. The seeds were sown in six rows, spaced 25 cm apart (each m 200 seed) in early May 2011. Space of plots was 1.5 m and replication were spaced 2.5 m from each other. The research area was ploughed in Feb 2011 and May 2011. After the application of 40 kg ha^{-1} nitrogen, 45 kg ha^{-1} P_2O_5 and 20 kg ha^{-1} K_2O, the site was harrowed to prepare the seed bed. Manuring was according to the provincial soil test recommendations before sowing. Seeds were pretreated with Mancozeb to minimize the probability of seed- and soil-borne diseases. Experimental plots were hand weeded.

In this study, 4 irrigation treatments were consisted of irrigation disruption during stem elongation (I_1), irrigation disruption during umbel emergence and grain filling (I_2), irrigation disruption during umbel emergence (I_3), irrigation disruption during grain filling (I_4) and well watered treatment (I_5).

Measurements

Essential oil was extract by Clevenger instrument. Essential oil of each sample, which was light yellow in color, was dried over anhydrous sodium sulphate and weighed.

Ten plants per plot were harvested and some traits such as plant height, number of umbel per plant, number of umbellate per umbel, biomass and grain yield were recorded.

The data were analyzed by using SAS software. Means were compared by Duncan's multiple range test at the 5% probability. Correlation coefficients between measured traits and factor analysis were done using SPSS software version 19.

RESULTS AND DISCUSSION

Analysis of variance and mean comparisons

The results of analysis of variance are shown in Table 1. The results showed that the irrigation treatments had significant effects on essence contents, but the other traits were not significantly affected by the treatments.

Mean comparisons (Table 2) showed that water limitation increased essence content. The highest essence content was obtained by irrigation disruption during stem elongation (I_1), while the dill plants under normal irrigation had the lowest essence. These findings suggest that dill essence is increased by moderate water deficit especially when the water limitation occurs during vegetative stage. Ghassemi-Golezani et al. [12] reported that the essential oil percentage of dill significantly improved, when plants were subjected to water stress during reproductive stages. This may be attributed to the function of secondary metabolites as self-defense components against stress conditions. In other words, the stress conditions accelerated the biosynthesis of essential oils [13]. Water disruption during different growth stage did not significantly influence grain yield and morphological traits. Similar results were reported by Zehtab et al. [14].

Table 1. Analysis of variance for some characters of dill in irrigated and rain-fed conditions

				Mean Square			
Source of Variation	df	Height	Umbel/Plant	Umbellate/Umbel	Biomass	Grain Yield	Oil Essence
Replication (R)	2	57.63^{ns}	502.87	16.47	1113.9^{ns}	177.3^{ns}	29032.4
Irrigation (I)	4	78.97^{ns}	727.1^{ns}	11.17	3075.3^{ns}	738.5^{ns}	7958.2^{ns}
Error (E)	8	44.45	877.4	20.47	1077.05	402.86	4221.3
CV (%)		6.9	25.46	13.44	26.48	25.82	22.32

Table 2. Mean values of analyzed traits for dill under irrigated and rain-fed conditions

Source of Variation	Height (cm)	Umbel/Plant	Umbellate/Umbel	Biomass (gm^{-2})	Grain Yield (gm^{-2})	Oil Essence (mg/50g DW)
I_1	97.67ab	99.3a	33a	173.8a	84.71a	370.3a
I_2	95.60ab	75.7a	32a	107.6b	65.67a	257.3ab
I_3	94.53ab	81.7a	33a	108.5b	81.02a	302ab
I_4	105.4a	62.6a	37a	136.5ab	58.88a	290ab
I_5	90.80b	98.3a	33.3a	93.2b	98.33a	235.7b
Mean	96.8	83.53	33.67	123.92	77.72	291.07
$LSD_{5\%}$	12.55	55.77	8.52	61.79	37.79	122.3

I_1: irrigation disruption during stem elongation, I_2: irrigation disruption during umbel emergence and grain filling, I_3: irrigation disruption during umbel emergence, I_4: irrigation disruption during grain filling and I_5: well watered treatment.

Table 3. Correlation coefficients between traits under different irrigation treatments in dill

	Height	Biomass	Grain Yield	Umbel/Plant	Umbellate/ Umbel	Oil Essence
Height	1					
Biomass	0.42	1				
Grain Yield	0.84*	-0.19	1			
Umbel/Plant	-0.81*	0.11	0.92**	1		
Umbellate/Umbel	0.84*	0.23	-0.47	-0.59	1	
Oil Essence	-0.34	0.63*	0.24	0.57	-0.61	1

I_1: irrigation disruption during stem elongation, I_2: irrigation disruption during umbel emergence and grain filling, I_3: irrigation disruption during umbel emergence, I_4: irrigation disruption during grain filling and I_5: well watered treatment.

Table 4. Main factors and factor loadings for some traits in dill

Traits	*1st Factor*	*2nd Factor*
Height	-0.985	0.157
Biomass	-0.261	0.942
Grain Yield	0.882	-0.056
Umbel/Plant	0.894	0.295
Umbellate/Umbel	-0.829	-0.105
Oil Essence	0.456	0.85
Variance (%)	58.5	28.5
Accumulative Variance	58.5	87.5

Relationships between traits

Correlation coefficients between traits were calculated and presented in table 3. Grain yield was positively correlated with plant height and number of umbel per plant. Number of umbellate per umbel had positive correlation with plant height. Biomass was positively correlated with essence content. A negative correlation was found between plant height and number of umbel per plant (table 3). By doing factor analysis, two main factors were identified determining 87.5% of total variation (Table 4). The first factor explaining 58.5% of the variance, emphasized on grain yield and umbel per plant (with positive factor loadings), and height and umbellate per umbel (with negative factor loadings). Therefore this factor was named yield and yield components. The second factor determined 28.5% of the total variation. Biomass and oil essence were important characters in the factor. Biomass was positively correlated with essence content. The factor was called essence production.

It seems that the essential oil content of dill can be increased partly by a moderate water deficit during vegetative stage (stem elongation). Intensive and moderate water stress can increase percent of essence oil, However moderate water deficit because of non significant effect on plant biomass can be led to increase in essential oil yield.

ACKNOWLEDGEMENT

This research was supported by Islamic Azad University, Kermanshah Branch. I would like to express my sincere gratitude to Dr. Abdollah Najaphy for his valuable suggestions and guidance on my research project.

REFERENCES

[1] Smith J.S.C., Jackson R., Pearson T.A., Fuster V., Yusuf S., Faergeman O., Wood D.A., Alderman M., Horgan J., Home P., Hunn M., Grundy S.M. 2004. Principles for national and regional guidelines on cardiovascular disease prevention: a scientific statement from the World Heart and Stroke Forum. Circulation. 109:3112–3121.

[2] Parsaee H., Shafei M.N., Boskabady M.H. 2006Effects of hydro-ethanolic extract of *berberis vulgaris* fruit on rabbit isolated heart. DARU. 14(4): 208-213.

[3] Zhang Z., Ho W.K., Huang Y., James A.E., Lam L.W., Chen Z.Y. 2002. Hawthorn fruit is hypolipidaemic in rabbits fed a high cholesterol diet. J. Nutr. 132:5–10.

[4] Bahramikia S., Yazdanparast R. 2008. Effect of hydroalcoholic extracts of *Nasturtium officinale* leaves on lipid profile in high-fat diet rats. J Ethnopharmacol. 115:116–1217.

[5] Hosseinzadeh H., Karimi G.R., Ameri M. 2002. Effects of *Anethum graveolens* L. Seed extracts on experimental gastric irritation models in mice. BMC Pharmacol. 2: 1–5.

[6] Selye H.A. 1936. Syndrome produced by diverse nocuous agents. Nature. 38: 32-35.

[7] Elliott G.R., Eisdorfer C. 1982. Stress and human health. New York: Springer Publishing, p 19

[8] Gerard E., Konrad B., Colin L., Jean-Marie M. 2000. Prospects for pharmacological intervention in Alzheimer disease. Arch. Neurol. 57: 454 – 459.

[9] Perrig W.J., Perrig P., Stahelin H.B. 1997. The relation between antioxidants and memory performance in the old and very old. J. Am. Geriatric Society. 45: 718 – 724.

[10] Yazdanparast R., Bahramikia S. 2008. Evaluation of the effect of Anethum graveolens L. crude extracts on serum lipids and lipoproteins profiles in hypercholesterolaemic rats. DARU. 16:88-94.

[11] Boogaard, R.V. 1995. Variation among wheat cultivars in efficiency of water use and growth parameters. Ph.D. Thesis, Utrecht University, pp. 155.

[12] Ghassemi-Golezani K., Andalibi B., Zehtab S., Saba J. 2008. Effects of water stress during vegetative and reproductive stages on seed yield and essential oil content of dill (*Anethum graveolens* L.). J. Food Agric. Environ. 6: 282–284.

[13] Ezz E., Aziz E.E., Hendawy S.F., Omer E.A. 2009. Response of *Thymus vulgaris* L. to salt stress and alar (B9) in newly reclaimed soil. J. Appl. Sci. Res. 5: 2165–2170.

[14] Zehtab S., Ghasemi K., Moghbeli S. 2006. Effect of Sowing Date and Limited Irrigation on the Seed Yield and Quality of Dill (Anethum graveolens L.). Turk J Agric For. 30: 281-286.