

Effect of drought stress and types of fertilizers on the quantity and quality of medicinal plant Basil (*Ocimum basilicum* L.)

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Abstract:

In order to study the effects of drought stress and three types of fertilizers on quantitative and qualitative characteristics on Basil (*Ocimum basilicum* L.) a greenhouse experiment in a factorial under randomized complete block design with three replications was conducted in 2011 at University of Zabol. Treatments included: Irrigation at three levels 100% (control), 80% FC and 60% FC and fertilizer treatments included non-fertilizer, chemical fertilizer, manure and compost (25 tons per hectare). In this study, drought stress led to increased essential oil percentage, whereas the greatest essential oil percentage obtained when 60% FC was applied. Increasing drought stress decreased the amount of dry yield, dry weight per plant, plant height, Subshrub and Internode number. Among fertilizers, chemical fertilizer had the highest effect on essential oil content. Results showed that Basil maximum essential oil content could be achieved applying 60% FC levels. Moreover, using manure fertilizer under high level of drought stress was more effective.

Keywords: Basil, Drought, Fertilizer, Quantity, Quality.

1. Introduction

Water stress is the most influential factors affecting crop yield particularly in irrigated agriculture in arid and semi-arid regions, it is necessary to get maximum yield in agriculture by using available water in order to get maximum profit form per unit area because existing agricultural land and irrigation water are rapidly diminishing due to rapid industrialization and urban development. Optimizing irrigation management due to water scarcity together with appropriate crops for cultivation is highly in demand; the cost of irrigation pumping and inadequate irrigation scheme capacity as well as limited water sources is among the reasons that force many countries to reduce irrigation applications. Potential of water stress tolerance and the economic value of medicinal and aromatic plants, make them suitable alternative crops in dry lands (Ghanbari *et al.*, 2007). *Ocimum basilicum* plant is one of the most important aromatic plants which used to flavor foods and in traditional medicines (Yusuf *et al.*, 1994). In aromatic plants, growth and essential oil production are influenced by various environmental factors, such as water stress (Burbott and Loomis, 1969). The aim of research conducted in the years 2010–2011 in Department of agronomy at Wroclaw University of zabol was the assessment of the effect of drought stress and types of fertilizers on the quantity and quality of grown basil.

2. Material and methods

This pot research conducted as factorial arranged in completely randomized design with three replications in 2011. Water deficit treatment in three levels was include of complete irrigation at field capacity (control), 80% of fc and 60% of fc, and fertilizer treatment in four levels was include of control, waste compost, manure (25 ton.ha-1) and chemical fertilizer. Pots with 25 cm in diameter and 30 cm in height were chosen as sowing environment. Water stress treatment takes place in weight method. In order to determination of moisture curve, 3 soil samples transferred to laboratory for further experiments. Pressure plate devise used on soil saturated samples. Soil was under stress with making suction by pressure plate devise. Therefore, considered water potential created in these three samples. After 24 hours, samples taken into the oven and were dried at 100 C for 24 hours. Then, soil weight moisture percentage determined in all three potentials. It was possible with this determination to measure the soil moisture content and pot weight in different potentials. Each pot weighing by sensitive balance every day (accuracy in gram) and with adding consumption water (weight loss of each pots), the irrigation treatments were applied. Each pot was kept constant in the treatment weight, and then, fertilizers were weighed and were generalized to a single pot. Harvest of samples to determination of essential oil percentage began at 25% flowering. Essential oil obtained by steam distillation method using Clevenger. MSTAT-C software for the analysis of variance and Duncan's multiple range test at 5% probability level were used.

3. Results and discussion

3.1 Dry yield

Results of analysis of variance show that drought stress and fertilizer treatments have a significant effect on dry yield of basil (Table. 1, 2). Means comparison based on Duncan multiple range showed that with increasing drought stress level from control to 60% of fc, dry yield per plant reduced by 22.84 kg.ha⁻¹ (Table.3, 4). Same results obtained by Pirzad et al., (2006) on chamomile and Hasani et al., (2004) on basil. Carter et al., (1982) reported that water deficit reduce the seed yield, number and diameter of stem, internode length and leaf size in alfalfa. On his research on *Dracocephalum moldavica* medicinal plant, Safikhani (2008) stated that drought stress at 40% of fc could lead to reduction of plant height, leaf length and width, internode length, shoot yield and essential oil yield. Although fertilizer treatment had no significant effect of dry yield of basil, but the highest yield with 218.628 kg war related to chemical fertilizer and there were no significant differences between manure and compost (Table. 4). Interaction effects of drought stress and fertilizer treatments show that the chemical fertilizer at 60% of fc treatment has the highest dry yield among other treatments (Table. 5).

Table. 1 Result of soil analysis at 0-30 cm depth.

Texture	Sand	Clay	Silt		Mn	Zn	Fe	K	P		N	OM	pH	EC
		%					ppm					%		
Sandy														
Loam	41	32	27	3.1	4.8	2.2	185	12	0.06	1.45	7.7	1.8		

Table. 2 Some characteristics of Animal manure and Compost.

Organic matter %	N%	P%	K%	pH	EC dS m ⁻¹	Moisture (%)	
26.5	1.71	0.72	2.59	7.6	6.6	38	(Animal manure)
19.6	1.1	0.4	1.24	7.2	7.4	32	(compost)

Table. 3 Mean square of some characteristics of basil under drought stress and different fertilizers

Mean Squares						df	S.O.V
Internode number	Subshrub	Height	Plant dry weight	Dry yield	Oil percentage		
2.11 ns	1.19*	11.56 ns	0.005 ns	0.005 ns	0.007 ns	2	Replication
25.07**	14.11**	122.83**	0.021**	0.021**	0.535**	3	Fertilizer
70.19**	20.86**	126.02**	0.053**	0.053**	0.929**	2	Drought stress
0.04 ns	0.86*	7.52 ns	0.001 ns	0.001 ns	0.060**	6	Drought stress × Fertilizer
0.02	0.31	11.24	0.003	0.003	0.003	22	Error
18.8	15.55	8.23	3.87	2.78	2.26	-	CV (%)

* and ** are significantly different $\alpha=0.05$, respectively and ns is non-significant

3.2 Plant dry weight, height, number of subshrub and internode

Analysis of variance showed that effects of drought stress and fertilizer treatments on all above mentioned traits were significant (Table. 3). Means comparison showed that with increasing drought stress from control to 60% of fc, plant dry weight reduced by 0.298 gr per pot (Table. 4). This reduction rates were 6.38 cm for height, 1.64 number subshrub per plant, and 5.50 number internode (Table. 4). Same results obtained by Safikhani et al., (2008) on *Dracocephalum moldavica* and Misra and Srivastava (2000) on japa-

nese Mint. According to Sreevalli et al., (2001), this reduction could be because of more allocation of photosynthetic material to root that shoot. The first sign of water shortage is reduction of cell turgescans and thereby reducing of cell growth, especially in stems and leaves. Organ size of plant will be limited with cell growth reduction and so, the first tangible effect of water deficit on plants could be found from their smaller height or leaves. In addition, nutrient absorption in water deficit condition is very limit. The results about number of subshrub and yield are consistent with that of japanese mint by Misra and Srivastava (2000) and on thyme by Johnson (1995). In this experiment, the number of subshrub decreased by increasing drought stress level which is consistent with Hasani and Omidbeigi (2004) on basil plant.

Table. 4 same characteristics of basil under drought stress and different fertilizers

Treatments	Oil percentage	Dry yield (Kg/h)	Plant dry weight (gr)	Height	Sub-shrub	Internode number
Drought stress						
FC	2.461 ^C	195.327 ^A	0.378 ^A	44.42 ^A	4.50 ^A	12.50 ^A
80% Fc	2.594 ^B	194.666 ^A	0.19 ^B	39.98 ^B	3.16 ^B	9.83 ^B
60% Fc	2.996 ^A	172.480 ^B	0.08 ^B	38.047 ^B	2.66 ^C	7.00 ^C
Fertilizer						
Control	2.387 ^C	153.003 ^C	0.66 ^B	35.250 ^B	2.22 ^C	7.222 ^B
Compost	2.708 ^B	188.176 ^B	0.50 ^A	41.888 ^A	2.33 ^B	10.000 ^A
Manure	2.659 ^B	190.247 ^B	0.41 ^A	43.361 ^A	3.44 ^B	10.111 ^A
Fertilizer	2.387 ^A	218.628 ^A	0.83 ^A	42.359 ^A	5.33 ^A	11.111 ^A
Means followed by similar letters in each column are not significantly different at p=5%, Duncan Multiple Range test.						

Table. 5 Same characteristics of basil under interaction effect of drought stress and different fertilizers

Treatments	Oil percentage	Dry yield (Kg/h)	Plant dry weight (gr)	Height	Subshrub	Internode number	
Fc	Control	2.152 ^H	165.4 ^{CD}	0.433 ^{CD}	40.47 ^{BC}	3.00 ^{DE}	10.00 ^D
	Compost	2.568 ^E	197.0 ^B	0.533 ^{AB}	45.27 ^{AB}	4.33 ^C	12.67 ^B
	Manure	2.565 ^E	199.0 ^B	0.493 ^{BC}	46.27 ^A	4.33 ^C	12.67 ^B
	Fertilizer	2.562 ^E	219.9 ^A	0.583 ^A	45.36 ^{AB}	7.33 ^A	13.67 ^A
80% Fc	Control	2.277 ^G	163.7 ^D	0.370 ^{DE}	35.34 ^C	3.00 ^{DE}	6.66 ^I
	Compost	2.635 ^E	197.4 ^B	0.420 ^{CD}	40.25 ^{BC}	3.66 ^{CD}	9.33 ^F
	Manure	2.424 ^F	199.7 ^B	0.430 ^{CD}	42.30 ^{AB}	3.66 ^{CD}	9.66 ^E
	Fertilizer	3.043 ^B	218.3 ^A	0.456 ^{CD}	40.90 ^{AB}	5.33 ^B	10.67 ^C
60% Fc	Control	2.732 ^D	129.9 ^E	0.296 ^E	29.94 ^D	1.00 ^G	5.00 ^J
	Compost	2.921 ^C	170.1 ^{CD}	0.406 ^{CD}	40.15 ^{BC}	2.00 ^F	8.00 ^H
	Manure	2.989 ^{BC}	172.0 ^C	0.400 ^D	41.51 ^{AB}	2.33 ^{EF}	8.00 ^H
	Fertilizer	3.343 ^A	217.7 ^A	0.410 ^{CD}	40.81 ^{AB}	3.33 ^D	9.00 ^G
Means followed by similar letters in each column are not significantly different at p=5%, Duncan Multiple Range test							

Higher subshrub under drought stress condition is an undesirable trait because it may cause loss of soil moisture. Ogbonnaya et al., (1998), considered the limitation of branches under dry condition as an adaptability mechanism. Chemical fertilizer had the best effect on all above traits (Table. 4). Interaction effects of drought stress and fertilizer treatments show that the chemical fertilizer in non-stress condition is the best treatment (Table. 5). Growth and yield enhancement with application of chemical fertilizers, because of increasing in availability of NPK for plant reported by Rezaeinejad and Afioni (2001) on maize and by Mallanagouda on onion (1995).

3.3 Essential oil percentage

Results of statistical analysis show that drought stress, fertilizer and interaction effect of them were significant on essential oil percent of basil (Table. 3). The highest and lowest rate of essential oil achieved from 60% of fc and control treatments, respectively (Table. 4). Differences between manure and compost wasn't significant and chemical fertilizer had the best amount of essential oil among fertilizer treatments (Table. 4). In this experiment, significant differences among different fertilizer treatments observed in aspect of essential oil (Table. 3). All of these treatments lead to increase of essential oil but the highest yield with mean of 2.387 was related to chemical fertilizer (Table. 4). On interaction effects, chemical fertilizer treatment in 60% of fc condition was the best treatment (Table. 5).

4. Reference

- 1• Burbott, AJ, Loomis, WD (1969). Evidence for metabolic turnover of monoterpenes in peppermint. *Plant Physiol* 44:173–179.
- 2• Carter, P, Sheaffer, C and Voorhees, W (1982). Root growth, herbage yield and water status of alfalfa cultivars. *Crop Sci*, 22: 425-427.
- 3• Ghanbari, A, Abedikoupai, J and Taie Semiromi, J (2007). Effect of municipal wastewater irrigation on yield and quality of wheat and some soil properties in sistan zone. *J. Sci. Technol. Agric. Nat. Resour.*, 10: 59-74.
- 4• Hassani, A, Omidbeigy B, and Heidary, H, Sharif Abad (2004). Evaluation of drought resistance indices in the basil plant. In *Journal of Agricultural Sciences and Natural Resources*, Year I, Issue 4, Pages 74-65.
- 5• Johnson, LUE (1995). Factors affecting growth and the yield of oil in Spanish thyme (*Lippia micromera* Schou). st. Augustine (Trinidad and Tobago), 132p.
- 6• Mallanagouda, B. (1995). Effects of N. P. K. and fym on growth parameters of Onion, Garlic and Coriander. *Journal of Medic and Aromatic Plant Science*, 4: 916-918.
- 7• Misra, A. and Srivastava NK (2000). Influence of water stress on japanese Mint. *Journal of Herbs, Spices and Medicinal Plants*, 7: 51-58.
- 8• Ogbonnaya, CL, Nwalozie, MC, Roy-Macauley, H and Annerose DJM (1998). Growth and water relations of Kenaf (*Hibiscus cannabinus* L.) under water deficit on a sandy soil. *Industrial Crops and Products*, 8: 65-76.
- 9• Pirzad, A, Alyari, H, Shakiba, MR, Zehtab-Salmasi, S and Mohammadi A (2006). Essential oil content and composition of german Chamomile (*Matricaria chamomilla* L.) at different irrigation regimes. *Journal of Agronomy*, 5(3): 451-455.
- 10• Rezaei Nejad, and Afioni, M (2001). The effect of organic matter on soil chemical properties, and its uptake by corn. *Journal of Agricultural Sciences and Natural Resources*, Volume 4, Issue 4, Pages 27-19.
- 11• Safi Khani, F, Heidary Sharif Abad, H, Siadat, A, Sharifi Ashourabady, A, Seiednejad, M and Abbaszadeh (2008). Effect of drought stress on yield and morphological traits, (*Dracocephalum moldavica*). *Journal of Medicinal and Aromatic Plants Research of Iran*, Volume 23, Number 2, Pages 194-183.
- 12• Sreevalli, Y, Baskaran, Y, Chandrashekara, R, kuikkarni, R (2001). Preliminary observations on the effect of irrigation frequency and genotypes on yield and alkaloid concentration in petriwinkle. *Journal of Medicinal and Aromatic plant Sci.* 22: 356-358.