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Original article

Investigate the different irrigation regimes and fertilizer treatments on morphophysiological characteristics of Balangu (*Lallemantia royleana* Benth)

M.A Fazli[1], T. Mir Mahmoodi[2*], A. Rahimi[3], S. Yazdan Seta[2]

1. Ph.D Student, Department of Agriculture, Agro Ecology and Seed Science and Technology, College of Agriculture and Natural Resources, University of Mahabad, Mahabad, Iran
2. Assistant Professor, Department of Agriculture, Agro Ecology and Seed Science and Technology, College of Agriculture and Natural Resources, University of Mahabad, Mahabad, Iran
3. Urmia University, Faculty of Agriculture, Department of Agronomy, Urmia. Iran

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Extended abstract

Introduction

Balango (*Lallemantia royleana* Benth) is a medicinal and annual plant of the mint family that contains essential oils and mucilage. The most important feature of Balango plant is its seeds. These seeds are an appropriate source of fiber, oil, and protein and have nutritional and health benefits for humans. Drought stress is one of the most important limitations of agricultural productions in arid and semi-arid regions including Iran. Recently, the impact of chemical farming and the negative consequences on the environment and human health are on the rise in Iran. Organic farming is gaining attention and increasing globally because it is eco-friendly, safe and has benefits for human health. The use of organic fertilizers in agriculture improves soil structure. The purpose of this research was to investigate the effect of irrigation and fertilizer treatments on morphophysiological characteristics of Balangu,

Materials and methods

In order to study the effect of irrigation regimes and fertilizer treatments on morphophysiological characteristics of Balangu, an experiment was conducted in a split-plot design with a randomized complete block design with three replications in the 2018 crop season. Experimental treatments included irrigation regimes at three levels (no irrigation, water deficit (supplemental) and normal) and fertilizer treatments including control, NPK, humic acid, Vermicompost, and manure. In this study, plant height, leaf area index, number of seeds per plant, 1000-grain weight, biological yield, grain yield, essential percent and essential yield, oil percent and oil yield mucilage percentage and mucilage yield were measured. After collecting the data, the data were analyzed using SAS software version 9.1 and the comparison of the average of the studied characteristics was performed using Duncan's test at the probability level of five percent.

[*]Correspondent author: Touraj Mir Mahmoodi; E-Mail: toraj73@yahoo.com.

Results

The results showed that the effect of irrigation regimes on plant height, leaf area index, number of seeds per plant, biological yield, grain yield, essential yield, oil yield, and mucilage yield were significant. Also the difference between fertilizer treatments on plant height, leaf area index, the number of seeds per plant, biological yield, grain yield, essential percent and essential yield, oil percent and oil yield, mucilage percentage, and mucilage yield. Furthermore, the effect of irrigation interval and fertilizer treatment interaction was significant only on 1000 grain yield. The highest plant height (70.29 cm), leaf area index (3.07), number of seeds per plant (168.72), biological yield (6712 Kg/h), grain yield (2297.7 Kg/h), essential yield (2.82 Kg/h), oil yield (497.16 Kg/h), and mucilage yield (295.74 Kg/h) were assigned to complete irrigation treatment. Among fertilizer treatments, the highest plant height (71.97 cm), leaf area index (3.67), the number of seeds per plant (158.06), biological yield (6063.3 Kg/h), grain yield (2086.3a), essential percent (0.12 percent) and essential yield (2.85), oil percent (21.11 percent) and oil yield (450.60a), mucilage percentage (12.48 percent), and mucilage yield (268.41a) were assigned to Vermicompost treatment. Also, the highest 1000-grain weight (5.38 g) was allocated to supplemental irrigation and vermicompost fertilizer treatment. Therefore, complete irrigation and application of compost organic fertilizer are recommended for achieving desirable characteristics of a Balangu.

Conclusion

Results showed that the highest biological yield, grain yield, essential percent and essential yield, oil percent and oil yield, mucilage percentage, and mucilage yield was recorded for complete irrigation regime, Therefore, in order to achieve the maximum quantitative and qualitative characteristics of Balango, additional irrigation is recommended. In the present study the highest biological yield, grain yield, essential percent and essential yield, oil percent and oil yield, mucilage percentage, and mucilage yield has belonged to Use of vermicompost, and this treatment was able to have a significant advantage over chemical fertilizers, so by replacing vermicompost with chemical fertilizer, in addition to economic savings, it took a step towards sustainable agriculture.

***Keywords*:** Humic acid, Leaf area index, Mucilage percentage, Vermicompost, Water deficit

Table 1. Analysis of variance (mean of squares) for effect of irrigation regim and manure on some characteristics of balangu

S.O.V	Df	Plant height	Leaf area index	Number of seeds per plant	1000-grain weight	Biological yield	Grain yield
Irrigation Regime (I)	2	151.38^{**}	2.21^{*}	38537.7^{**}	5.46^{**}	10257856^{**}	7088748^{**}
E1	4	7.28	0.12	5116.7	0.10	199414	59789
Manure (M)	4	302.91^{**}	3.76^{**}	7338.0^{**}	3.59^{**}	18838909^{**}	1218840^{**}
I × M	8	8.70^{ns}	0.13^{ns}	659.6^{ns}	0.28^{*}	46634^{ns}	83176^{ns}
E2	24	19.95	0.12	684.65	0.11	363475	44764
CV%		*3.66*	*13.28*	*22.21*	*9.39*	*10.28*	*13.32*

Table 1. Continued

S.O.V	Df	mucilage percentage	mucilage yield	essential percent	essential yield	oil percent	oil yield
Irrigation Regime (I)	2	6.42^{ns}	134947^{**}	0.00032^{ns}	11.88^{**}	9.35^{ns}	365341^{**}
E1	4	2.55	3810	0.00014	0.31	8.40	12752
Manure (M)	4	9.35^{**}	29754^{**}	0.0008^{**}	2.87^{**}	27.47^{**}	85134^{**}
I × M	8	0.57^{ns}	3315^{ns}	0.00008^{ns}	0.29^{ns}	1.92^{ns}	7785^{ns}
E1	24	1.49	1772	0.00014	0.16	5.38	5812
CV%		*10.22*	*21.37*	*10.19*	*21.34*	*11.35*	*22.78*

ns,** and * are no Significant, Significant at 1 and 5% probability levels, respectively

Table 2. Mean comparison of means of simple effects between Irrigation Regime and Manure on some characteristics of balangu

	Plant height	Leaf area index	Number of seeds per plant	Biological yield	Grain yield
	cm			----------Kg/h----------	
Irrigation regimes					
no irrigation	63.39^{b}	2.31^{c}	67.34^{c}	5059.6^{c}	925.1^{c}
supplemental	67.13^{b}	2.68^{b}	117.38^{b}	5829.3^{b}	1542.7^{b}
normal	70.29^{a}	3.07^{a}	168.72^{a}	6712.1^{a}	2297.7^{a}
Fertilizer treatments					
control	57.46^{c}	1.95^{d}	84.16^{d}	4173.2^{d}	1125.7^{d}
NPK	67.74^{ab}	2.46^{c}	114.13^{bc}	5408.4^{c}	1557.5^{c}
humic acid	67.13^{b}	2.44^{c}	100.69^{cd}	5360.9^{c}	1388.2^{c}
Vermicompost	71.97^{a}	3.67^{a}	158.06^{a}	8063.3^{a}	2086.3^{a}
manure	71.29^{ab}	2.89^{b}	132.03^{b}	6329.3^{b}	1748.9^{b}

Table 2. Continued

	Mucilage percentage	Mucilage yield	Essential percent	Essential yield	Oil percent	Oil yield
		Kg/h	%	Kg/h	%	Kg/h
Irrigation regimes						
no irrigation	11.31^{a}	106.59^{c}	0.12^{a}	1.05^{c}	19.65^{a}	185.93^{c}
supplemental	11.97^{a}	188.62^{b}	0.11^{a}	1.82^{b}	20.45^{a}	321.03^{b}
normal	12.62^{a}	295.74^{a}	0.11^{a}	2.82^{a}	21.23^{a}	497.16^{a}
Fertilizer treatments						
Control	10.23^{b}	118.35^{d}	0.10^{c}	1.17^{c}	17.80^{c}	205.77^{c}
NPK	12.72^{a}	201.77^{bc}	0.117^{ab}	1.86^{b}	20.45^{ab}	324.47^{b}
humic acid	11.93^{a}	167.28^{c}	0.11^{f}	1.60^{b}	20.25b	285.50^{b}
Vermicompost	12.48^{a}	268.41^{a}	0.120^{ab}	2.85^{a}	21.11^{ab}	450.60^{a}
manure	12.53^{a}	299.12^{ab}	0.127^{a}	2.28^{a}	22.62^{a}	401.18^{a}

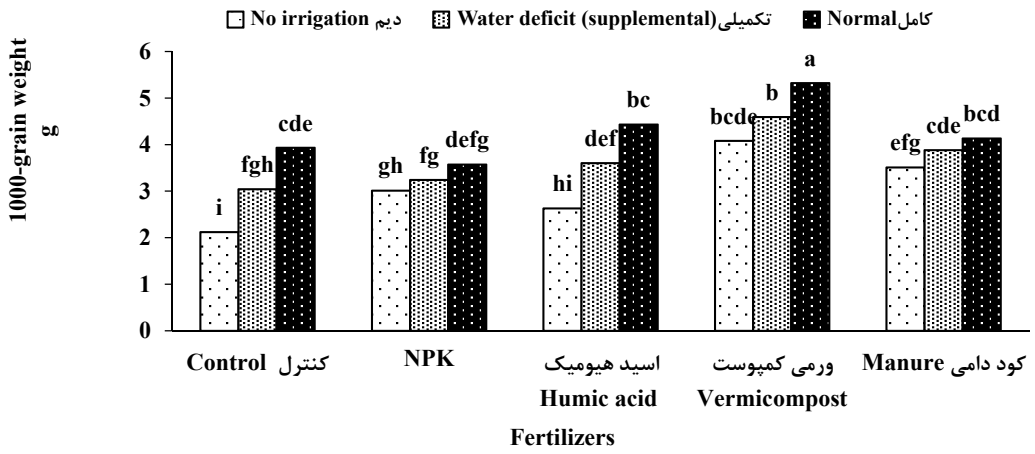

Fig. 1. Mean comparison for interaction effects of Irrigation Regime and Manure on 1000-grain weight of balangu