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EXTENDED ABSTRACT

Effect of Different İrrigation Regimes on Quantitative and Qualititative Characteristics of Peppermint Medicinal Plant

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Introduction

Regulated Deficit Irrigation (RDI) is the strategy of reducing irrigation rates, during a specific period of growth and development, with the objective of conserving water and managing plant growth while maintaining or improving yield and quality. Partial root zone drying (PRD) is a possible irrigation technique that deliberately exposes the plant to water deficits to induce physiological responses that can improve the efficiency of water use. It involves irrigating only one part of the root zone in each irrigation event, leaving another part to dry to certain soil water content before rewetting by shifting irrigation to the dry side.

Various plants are different in economic efficiency of irrigation water used. Medicinal plants, as a collection of plants with high economic value, can produce more capital than other plants in terms of water scarcity. The objective of this study was to determine the response of peppermint yield components, oil yield, and water use efficiency to regulated deficit irrigation and partial root-zone drying in field condition.

Methodology

The field experiments were carried out with two harvest in 2013 at the research farm of Sari Agricultural Sciences and Natural Resources University, Sari, Iran. The experimental design was a randomized complete block with four replications and eight irrigation treatment. Irrigation treatments were consisted of full irrigation (FI) that received 100% of evaporation demand; regulated deficit irrigation (RDI) treatments including RDI85, RDI70, RDI55 and RDI40 receiving 85, 70, 55 and 40% of FI treatments at each irrigation event, respectively; Partial root zone drying (PRD) techniques including PRD70, PRD55 and PRD40 receiving 70, 55 and 40% of FI treatments in one side of root zone at each irrigation event, respectively.

Plants were harvested in mid-flowering stage. Plants were weighed for fresh herbage yield and then air dried in shade for one week and then were weighed for biological yield. Flowers and aerial parts essential oil contents were determined using a Clevenger apparatus. Air-dried flowers and leaves were finely ground and eighty grams subjected to 500 ml water distillation and run for 3 hours using Clevenger apparatus. The essential oil content and percentage of essential oil was calculated in 80 grams of dried content. Data were subjected to analysis of variance using SPSS statistical package (version 21). Each treatment measured parameters means were compared using Duncan multiple range test ($p < 0.01$).

Results and Discussion

Irrigation treatments had a significant effect on fresh herbage yield and biological yield. Fresh herbage yield increased by increasing the depth of applied water. Maximum fresh herbage yield was corresponded to FI treatment (9427 kg.ha-1) whereas the lowest one was observed in RDI40 treatment (5729 kg.ha-1). Biological yield significantly decreased by implementing deficit irrigation practices. Similar to the results of fresh herbage yield, the highest biological yield achieved in FI treatment (1942 kg.ha-1) and the lowest one observed in RDI40 treatment (1288 kg.ha-1). There was no significant difference in leaves weight and stem and wooden parts weight between treatments. Wet harvest index shows upward trend in both PRD and RDI treatment but there was no significant difference between treatments.

The highest essential oil ratio achieved in PRD55 and PRD70 at rate of 2.45% and 2.38%, respectively. There was no significant difference between FI and RDI treatments. the highest oil yield achieved in PRD70 treatment (23.67 kg.ha-1) and lowest one obtained in RDI40 treatment (11 kg.ha-1). Despite decreasing irrigation regimes, there was no significant difference between RDI and FI treatments. In RDI treatments, both essential oil yield and oil ratio indicated upward trend to RDI70 treatment and after that, it decreased with applying more water deficit level. Applying PRD70 and PRD55 significantly increased oil yield. PRD treatments outperformed RDI treatments in term of oil yield and also it was more than full irrigation treatment. Wet harvest index based on oil yield increased significantly by adjusting water deficit. Highest oil harvest index achieved at PRD55 treatment; 0.0032. The lowest wet harvest index based on oil yield obtained in FI treatment; 0.0015. Also there was no significant difference between RDI treatments. Wet harvest index decreased by applying 40% water deficit in both RDI and PRD treatment.

There was no difference between plant yield components in second harvest. But there was significant difference between essential oil yield components that highest oil yield achieved in PRD55.

Conclusions

Irrigated agriculture as the major user of fresh water will likely experience greater pressure for improved water use efficiency. Deficit irrigation will be an important management technique to cope with the water scarcity. According to the result of present study, deficit irrigation strategies are valuable tool for improving water use efficiency in peppermint herb, achieving 45% water savings and maintaining sustainable production level. Partial root zone drying in peppermint clearly decreased plant biomass yield, however, oil yields increased across applied drought stresses. Lower peppermint biomass yield with higher oil yields would mean lower transportation costs and lower distillation costs. In a situation which producing peppermint leaves is concerned, according to the results and insignificant changes in leaves weight, PRD40 treatment would be suggested. It is possible to achieve about 60% of water saving and also reasonable yield compared to the full irrigation. According to the results and since the major goal of peppermint production is gaining its oil, it would be highly recommended to apply partial root zone technique with 70% or 55% of field capacity.