Effect of partial rootzone drying (PRD) on physiological parameters, carbohydrate accumulations, yield and water use efficiency (WUE) of tomatoes on soilless culture

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Introduction

Increasing water use efficiency became one of the main strategic goals of the researchers as well as decision-makers' world wide due to water scarcity and continues huge demand of water for agricultural irrigation. Consequently, studies in new low cost composted materials as well as irrigation techniques and approaches such as partial rootzone drying (PRD) seem to be of primary importance now and in the future for proper water use efficiency and rational water utilization. Tomato has the highest acreage of any vegetable crop in the world and is the second most common grown vegetable crop in Malaysia, therefore, studying the effects of low cost irrigation technique such as partial rootzone drying (PRD) could make substantial contribution to saving of water. The objective of this study therefore, is to understand how PRD works within soilless media amended with rice straw compost by monitoring water use efficiency; fruit yield and vegetative growth, as well as quantifying the impacts of PRD on proline and carbohydrate accumulations within the leaf.

Materials and Methods

Study was conducted at Hydroponics Unit, Crop Science Department, Faculty of Agriculture, UPM, Malaysia. Tomato (*Lycopersicon esculentum* Mill.) cv (Red Rock) F_1 hybrid was used in this study. Seeds were sown on germination trays with media of peat amended by rice straw compost (3:1) and transplanted four weeks later. Seedlings with the same vigor were transplanted to a double pot, where tap root was removed and the roots were approximately divided in the two pots, under shade-house condition with daily average temperature of 32 and 28 °C day and night, respectively and average relative humidity of 65% and 80% day and night respectively. Drip irrigation was used with a single emitter for each pot and the treatment started two weeks later. A number of parameters were monitored including leaf expansion, stomatal conductance, plant leaf area, proline and carbohydrate accumulations, water use efficiency (WUEs) and marketable and total yields

Results and Discussion

The results showed that PRD significantly ($p<0.05$) reduced leaf expansion, plant leaf area and stomatal conductance, whereas proline and sugars namely fructose, glucose and sucrose, were dramatically increased in the leaf. However, stomatal conductance, leaf expansion and proline accumulation significantly correlated with media drying. These results were in line with previous results elsewhere (Loveys et al., 1998; Stoll et al., 2000; Awad, 2001) and might be attributed to the signal coming from dried part of the root system throughout the stream of the xylem sap. The signal, which may leads to the partial closure of stomatal of PRD plant, may be attributed to a number of hormones of which ABA. The results from increasing these chemicals and others were closing of stomatal conductance and decline of transpiration rate (Bacon et al., 1998; Dry and Loveys, 1999). Dry matter partitioning showed no significant reduction in total dry matter and plant dry shoot, root weight and root to shoot ratio. . Thus there were also no significant differences between plant total and marketable yields due to PRD application. Both WUEs increased significantly with PRD. This results were supported by numerous studies demonstrated that PRD application resulted in no significant reduction of crop yield (Loveys, 1991). This result suggests that PRD application could be affective with soilless media where was high total carbon provided under Malaysia humid condition that characterized by high evaporative demand.

Table 1: Effect of partial rootzone drying system (PRD) on plant leaf area, dry matter partitioning, total and marketable yields and plant water use efficiency (WUE) of tomato plant grown in soilless media

Parameter	Control	PRD	Lsd	C.V.
Plant leaf area (cm2)	1739.53a	1507.45b	156.7	4.26
Plant dry biomass (g)	45.67a	41.67a	9.39	9.49
Plant dry shoot wt. (g)	40.00a	35.17a	6.58	7.72
Plant dry root wt. (g)	5.67a	6.50a	3.31	24.02

Root to shoot ratio	0.14a	0.19a	0.07	19.52
Plant total yield (g)	852.8a	744.3a	292.12	16.14
Plant marketable yield (g)	786.76a	721.77a	113.32	6.63
Water use efficiency1 (g/kg)	1.56b	2.39a	0.47	10.40
Water use efficiency2 (g/kg)	34.48b	43.99a	7.49	8.42

Conclusions

PRD decreased leaf expansion, stomatal conductance as well as plant leaf area, whereas increased proline and carbohydrate accumulations. PRD, on the other hand, increased water use efficiency (WUEs) of tomato by up to 50 %and 28% compared to control plants as dry biomass and total yield respectively, without significant reduction in yield. It can be concluded that PRD application could be more effective with soilless media where was high total carbon provided.

Benefits from the study

improve efficiency in crop production using soilless culture

Patent(s), if applicable:

Nil

Stage of Commercialization, if applicable:

Nil

Project Publication in Refereed Journal

Hassan Ibrahim Ali, Mohd Razi Ismail, Mohd Mokhatruddin Manan, Halimi Mohd saud and Yasmeen Siddiqui (2003) Composting as one of the means of alternatives rice straw management under humid conditions. Journal of Ecology Environment and Conservation. 9(1): 1-5

Hassan Ibrahim Ali and Mohd Razi Ismail (2003) Biodynamic preparations: A review. Asian Journal. Microbiol. Biotech. Env. Sc. Vol. 5, No (1): 37-40

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MOHAMAD HAMAD AWAD, MOHD RAZI ISMAIL, MARZIAH MAHMOOD and MAHMUD T. M. MOHAMAD (2002) The exploitation of root-sourced signals to reduce irrigation and to regulate leaf growth of pepper plants Capsicum annuum L. Pertanika Journal Tropical Agricultural Science; in press

Project Publications in Conference Proceedings:

Nil

Graduate Research

Name of Graduate	Research Topic	Field of Expertise	Degree Awarded	Graduation Year
Erwan Bachtiar	**The use of oil palm frond as soilless additive in cauliflower crop production**	**Horticulture**	**MSc**	**2003**

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