Effects of root cooling on growth and yield of lowland cauliflower grown in hydroponics

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Introduction

Cultivation of cauliflower in Malaysian lowland is not fully exploited due to unfavorable environmental conditions. Cauliflower is one of the vegetables listed in the major imported vegetables contributing to 6.7% of the total import of vegetables worth more than RM 51 million (Kementerian Pertanian, 1997). The use of protected structures in lowland subjected plants to high air temperature causing detrimental effects to plant development. Ambient tropical conditions of high temperatures and light intensities severely reduce growth of temperate vegetables if they were to be grown under lowland conditions. However, there is now clear evidence root cooling can offset detrimental effect of high air temperature. Lee and Cheong (1996) reported that certain cultivars of iceberg lettuce grown aeroponically were successfully induced to form compact heads under warm atmospheric conditions reaching 40 C, but with the root zone maintained at 15 C. Regulating root environment to modify plant physiological and biochemical processes can be carried out using hydroponics. The project was carried out to evaluate the effects of lowering root zone temperature on growth and yield of lowland cauliflower.

Materials and Methods

Four-week cauliflower seedling variety Chia Tai were transferred to Nutrient Film technique and grown in a plastic house at the Hydroponics Unit, University Putra Malaysia, Malaysia. The plants were grown under normal climatic conditions in the plastic house for another 7 days for root establishment. The plants were grown full strength of Cooper formulation(Cooper, 1975). A group of plants was grown without root cooling throughout the plant growth. The other group of plants were grown in the ambient solution temperature. Root cooling was imposed both by placing an iceblock in the insulated nutrient tank. The temperature of the nutrient solution was brought to 15-18° C compared to 28-30°C without root cooling. The experiment was conducted in a completely randomized design with 10 replication for each treatment.

Leaf area, leaf dry weight , total plant dry weight and curd fresh and dry weight were determined at harvest. Similarly, leaf area was determined using an automatic leaf area meter (Delta-T, Cambridge, UK). Visual observation on curd quality was made at harvest. Stomatal conductance was measured on young fully developed leaves by using a porometer (AP-4, Delta-T, Cambridge, UK). Leaf photosynthetic rate was measured on the same leaf used in stomatal conductance using an infrared gas analyser (LCA3, Analytical Development Company, Hoddesdon, UK).

Results and Discussion

Root cooling treatments significantly increased leaf dry weight, leaf area and total plant dry weight compared to the non-cooled control. The result agreed with other published reports on the benefit of supra-optimal root zone temperature on vegetable species (pepper, Dodd *et al.*, 2000 , lettuce, Lee and Cheong, 1996 ; cucumber, Tachibana *et al.*, 1997). There was an imbalance of assimilate partitioning when plants were grown in root cooling treatments when curd initiation was delayed due to excessive source available for vegetative instead of reproductive development. Hence, there was no significant difference between treatments on yield of curd.

Table 1: Effects of root cooling on growth and yield of lowland cauliflower grown in hydroponics

Treatments	Leaf area (cm^2/leaf)	Leaf fresh weight (g/plant)	Leaf dry weight (g/plant)	Yield (g/plant)

Ambient	1937a	214.63 a	11.31a	191.62a
Root cooling	2383b	241.97 b	15.37b	197.82a

Means separation by DMRT.. Mean with the same letter indicate not significant at P0.05

Similar to the effects on vegetative growth, plants grown in root cooling treatments exhibited higher stomatal conductance and photosynthetic rate compared to plants grown in ambient solution temperature. Dodd et al. (2000) showed that exposing plants that were grown in high ambient temperature to a lower root temperature significantly increased water relations and stomatal conductance. Alteration of hydraulic conductivity have in turn affected water relations which is hypothesized to have directly affected the stomata . Consequently, these has resulted to a rapid vegetative growth in root cooling treatments.

Table 2: Effects of root cooling on stomatal conductance and photosynthesis rate of lowland cauliflower grown in hydroponics.

Treatments	Stomatal conductance mmol m^2 s	Photosynthesis rate µmol m^2 s
Ambient	347.5a	10.6a
Root cooling	587.5b	15.4b

Means separation by DMRT.. Mean with the same letter indicate not significant at P0.05

Conclusions

The data frown this study show that vegetative growth of cauliflower plants was accelerated with imposing low root temperature. The increased in growth was due to the improvement of plant water status indicated by higher stomatal conductance compared to the plants grown in ambient solution temperature. The accelerated vegetative growth was however, causing a negative impact on the initiation of curd and yield. In the growing condition where water and nutrient are not a limiting factor, imposing a certain degree of root stress is important to ensure a balance assimilate partitioning between vegetative and reproductive stages.

Benefits from the study

Installation of root cooling infrastructure to improve plant development is expensive and beyond reach of local farmers. The study shows that root cooling is not essential for crop such as lowland cauliflower.

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Expertise Development

Name of Graduate	Degree Awarded	Field of Expertise	Graduation Year
Puteri Edaroyati M Wahab	Master	Plant Physiology	1999

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