GROWTH, PHYSIOLOGICAL AND BIOCHEMICAL RESPONSES OF WATER STRESSED PEPPER PLANTS AND WATER USE EFFICIENCY

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Introduction

Water deficit is one of the principal environmental limiting factors for crop production through out the world that causes significant yield reduction. It has been shown that the rate at which a deficit develops can affect the nature and or the extent of the plant response. This applied over a wide range of physiological and metabolic processes which may be affected by water stress including growth, stomatal closure, photosynthesis, osmoregulation and enzyme activity (Smirnoff et al. 1985). Pepper cultivars excepted to exhibit differential responses under water deficit. However, investigating these responses helping solved the lack of suitable cultivar(s) for drought conditions. Therefore our aim was to study the effect of water stress on the growth, physiological and biochemical responses of three pepper (*Capsicum annuum* L.), cultivars viz. Padi, Kulai and MC12, under protected environment and to categorize the tested cultivars according to their responses.

Materials and Methods

Seeds of pepper (*Capsicum annuum* cv Padi, Kulai and Mc12) were germinated and raised under greenhouse at the Hydroponics unit, Faculty of Agriculture UPM. After 45 days, seedlings were selected for uniformity and transferred to black polybag containing seven kilograms of soil mixture (top soil Serdang series, sand and peat mos.) at a ratio of 3:2:1 respectively. The plants were watered daily to the bag capacity until treatment starts. Ten grams of compound fertiliser (NPK 15:15:15) were applied to each polybag a week after transplanting and plants were sprayed against insects when needed. The experiment was conducted in split plot arrangement with four replicates. The watering regimes (control of daily irrigation to bag capacity and withholding water until plants undergo visible wilting at night) were allocated to the main plots and the three pepper cultivars to the subplots. Over 7days, soil water status, leaf and root growth, leaf water potential, stomatal conductance, photosynthesis, leaf area, plant fresh and dry weight, protein and proline content of the leaves were determined. All physiological measurements were carried out in fully expanded leaves.

Results and Discussion

Midday leaf water potential (ψ) of control plants of all cultivars remained high (less negative) as compared with that of stressed plants through the experimental period. Cv. Padi ψ decreased more rapidly after the onset of stress than did cv. Kulai and Mc12, leading to an earlier reduction in stomatal conductance and photosynthetic rate. Mc12 and Kulai stressed plants ψ decreased gradually and reached the minimum value 2 days after the onset of stress resulting in a continuos decrease in stomatal conductance and photosynthesis. These findings confirmed a previous report (Mohd Razi and Davies, 1997), that water deficit affected several physiological aspects including photosynthesis leaf water potential and stomatal conductance. After re-watering all the measured physiological parameters in all cultivars started to recover. Mc12 cv. Physiological processes of stressed plants recovered more rapidly after re-watering as compared with that of Kulai or Padi. This phenomenon was attributed to the difference in sensitivity of leaf water potential of each cultivar to environmental conditions and to the ability or inability of those cultivars to maintain water supply to the leaf. Barnett and Naylor (1966) reported the accumulation of proline due to water stress. Proline accumulation in plants can be considered as soluble nitrogen sink and play an adaptive role. In fact, proline synthesis has been associated with protein hydrolysis induced by water stress In this study, there was slight increase in free proline level in leaves of capsicum cultivars. The difference between control and stressed plants remained insignificant until day 3 from the onset of water withholding. Stressed plants of cv Kulai and Padi had a higher level of accumulated proline as compared with that of cv. Mc12. After re-watering the proline level of stressed plants started to decline and reached that of control plants on day 4. A similar trend was observed in soluble protein content of the leaves of stressed plants. According to these findings, the sharp increase in proline accumulation coincides with the decrease in reduction in leaf water potential, consequently it should not be the result of protein hydrolysis, since the soluble protein of stressed plants remained unchanged. Venekamp et al. (1989) observed similar results in *Vicia faba.* They reported that drought induced proline synthesis was the result of organic acids formation which provide the carbon skeleton to synthesize proline.

Conclusions

The findings presented in this study revealed that water deficit has a profound effect on the growth and development of pepper cultivars. Mc12 cv. Maintained its yield to some extent under water deficit stresses of this study as a consequence of early recovery of it physiological processes. The tendency of Mc12 to to enter flowering stage 30 days after germination could encourage the plants to complete their life cycle before the onset of stress. Further studies at cellular level are needed to give good understanding of the adaptation mechanism.

References

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