A COMPARATIVE STUDY ON THE PHYSIOLOGICAL RESPONSES OF MOISTURE STRESS IN SELECTED CHILLI CULTIVARS DURING THE FLOWERING STAGE AND THE IMPACT ON YIELD

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Introduction

Agricultural crops obtain water periodically during the growing season, either by natural rainfall or by irrigation. In between periods of water availability, soil moisture stress sometimes becomes severe and limits plant growth and development. Even brief water shortage is likely to interfere with the normal function of plants (Techawongstien *et al.*, 1992).In chilli, after a period of vegetative development, reproductive growth including flower opening and fruit development and vegetative growth occur concurrently. MI 2, KA 2 and "Arunalu" are the commonly cultivated chilli cultivars inSri Lanka.Stomatal Resistance, Transpiration Rate and Relative Water Content are certain physiological parameters which act as indicators for moisture stress. It is the physiological parameters which ultimately affect the yield during stress periods.The present study was conducted with the objectives of comparing the physiological responses of selected chilli cultivars to moisture stress and to evaluatethem for drought resistance.

Methodology

Studies were conducted in the '*Yala*' 2011 at the Agronomy farm of the Eastern University of Sri Lanka which is located at an elevation of 75m above mean sea level. The climate here is warm (28°C-34°C) with an average annual rainfall of 1250mm.The land was cleared, ploughed and leveled. A number of twenty four plots each consisting a dimension of 3m 2m was constructed. A distance of 2m was maintained between plots.Rain shelters were constructed. The seeds of the three chilli cultivars, namely; MI 2, KA 2 and 'Arunalu' were soaked in 'Captan' fungicide solution (250g seeds in $2gl^{-1}H_2O$) before sowing on the nursery beds.The seedlings were transplanted on the ridges at a spacing of 60cm 45cm. The experiment was managed in accordance with the recommended cultural practices.The fertilizer mixture containing 240g Triple Super Phosphate and 120g Muriate of Potash was added as basal to each plot. The first application of Urea (156g $plot^{-1}$) as top dressing was done during the second week after transplanting. The subsequent applications of Urea (204g $plot^{-1}$) were made during the 4^{th}, 8^{th}, 12^{th} and 14^{th} week after transplanting. Muriate of Potash(120g $plot^{-1}$) was applied for the 2^{nd} time during the 8^{th} week after transplanting.The treatments were arranged factorially following the Randomized Complete Block Design with six treatments and four replications. The treatments are as follows:

T1=Moisture stress was imposed for the MI 2 chilli cultivar during the flowering stage for a period of 15 days.

T2= Regular watering of MI 2 chilli cultivar to Field Capacity at 5 days interval.

T3= Moisture stress was imposed for the KA 2 chilli cultivar during the flowering stage for a period of 15 days.

T4=Regular watering of KA 2 chilli cultivar to Field Capacity at 5 days interval.

T5= Moisture stress was imposed for the 'Arunalu' cultivar of chilli during the flowering stage for a period of 15 days.

T6= Regular watering of 'Arunalu' cultivar of chilli to Field Capacity at 5 days interval.

Stomatal resistance (RS) and Transpiration rate (TR):
A number of ten leaves representing ten plants were randomly selected from each replicate of the treatments to determine the RS and TR. These parameters were measured by a Portable Steady State Porometer (LI-1600, LI-COR Inc, USA) during the flowering stage for the stressed and control plants.

Relative water content (RWC):
A number of ten leaves representing ten plants were randomly collected from each replicate of the treatments for the determination of RWC. Leaf samples were kept inside the polyethylene bags. Similar sized discs (3cm diameter) were obtained and their Fresh Weight(FW)was recorded soon after collection. These discs were placed overnight in a beaker containing de-ionized water to obtain Turgid Weight(TW). The leaf discs were blotted with filter papers to dryness and their TW was recorded. The leaf discs were then placed in the oven at 80°C for 24 hours and their dry weight (DW) was recorded.

Ripened fruits were harvested in 6 pickings from the tested plants. The fruits were oven dried at 105°C for 48 hrs and their dry weight was recorded. The data were statistically analyzed and the difference between means was compared by DMRT.

Discussion and Conclusion
It was found that there were significant differences between treatments in the stomatal resistance (RS), Transpiration Rate (TR) and Relative Water Content (RWC) of leaves of the selected chilli cultivars. In the treatments where moisture stress was imposed for chilli plants during the flowering stage, the RS on the 15th day from the commencement of the stress was significantly higher than the control values (Table 1).

Stomatal resistance (RS)
It was observed that there were no significant differences in the RS values of MI 2, KA 2 and 'Arunalu' chilli cultivars which experienced moisture stress. This indicates that these cultivars would have had similar stomatal opening. Stomatal closure which results from soil water depletion is mediated by changes in root water status (Bates and Hall, 1981). Several studies suggest that the leaf conductance of some plant species is closely coupled to leaf water status.

Table1: The effects of soil moisture stress on the Stomatal Resistance (RS) of selected chillicultivars during the flowering stage

Cultivars	Stomatal Resistance (scm^{-1})	
	Stress	Control
MI 2	37.1 ^{b}	0.92 ^{a}
KA 2	35.7 ^{b}	0.86 ^{a}
'Arunalu'	36.2 ^{b}	0.90 ^{a}

Transpiration rate (TR): It was found that there were no significant differences in the TR values of MI 2, KA 2 and 'Arunalu' chilli cultivars which were exposed to moisture stress (Table: 2). Reduction in the TR would have either been due to increased stomatal resistance or reduced leaf water potential. Similar TR values expressed by these plants reflect similarity in the stomatalopening. Jarvis and Mc Naughton (1996) stated that the stomata would be an essential if not sole regulator of the transpiration.

Relative water content (RWC): It was observed that there were significant differences in the RWC of MI 2, KA 2 and 'Arunalu' chilli cultivars during moisture stress (Table: 3). The cv. 'Arunalu' showed the highest RWC followed by KA 2 and MI 2. This indicates that the 'Arunalu' chilli cultivar was able to conserve considerableamount of moisture in the leaf tissues despite a severe drought condition. This is a stress tolerance feature of this cultivar. KA 2 cultivar was also able to thrive drought by conserving moisture. When water is withheld from a plant, the tissues suffer from water deficit and leaves show reduced RWC values. Martin *et al.*(2009) found that cultivars which were believed to be more drought resistant usually maintain higher leaf RWC under stress condition.

Table 2: The effects of soil moisture stress on the Transpiration Rate (TR) of selected chilli cultivars during the flowering stage

Cultivars	Transpiration Rate ($\mu gcm^{-2}s^{-1}$)	
	Stress	Control
MI 2	0.66 [b]	9.2 [a]
KA 2	0.58 [b]	10.1 [a]
'Arunalu'	0.61 [b]	9.8 [a]

Table 3: The effects of soil moisture stress on the Relative Water Content (RWC) of selected chilli cultivars during the flowering stage

Cultivars	Relative Water Content (%)	
	Stress	Control
MI 2	56.8 [d]	92.6 [a]
KA 2	64.3 [c]	91.4 [a]
'Arunalu'	77.9 [b]	92.0 [a]

Yield: It was found that there were significant differences between treatments in the yield of chilli (Table 4). Moisture stress significantly reduced the yield of all the three chilli cultivars. The highest reduction was observed in the MI 2 followed by KA 2 and 'Arunalu'. There was no significant difference in the yield of KA 2 and 'Arunalu' under stress condition. These two cultivars were able to produce substantially high yield under water scarce situation. A relatively high RWC in the 'Arunalu' chilli cultivar compared to MI 2 and KA 2 under stress condition would have helpedto maintain turgid mesophyll leaf tissues in this cultivar. As a result, the growth and development of 'Arunalu' would have continued despite a severe stress.Hence, 'Arunalu' cultivar was able to thrive well and producesubstantial yield under water deficit situation.

Table 4: The effects of moisture stress on the yield of selected chilli cultivars during the flowering stage.

Cultivars	Yield ($kgha^{-1}$)	
	Stress	Control
MI 2	772 [d]	3413 [b]
KA 2	982 [c]	2417 [a]
'Arunalu'	1099 [c]	2183[a]

This study determined the extent to what moisture stress affects Stomatal Resistance, Transpiration Rate, Relative Water Content and ultimate yield of the three chilli cultivars. A comparison of the physiological characteristics was made. 'Arunalu' cultivar of chilli was able to resist drought than the other two cultivars and produced substantially high yield. The

drought resistant feature of this cultivar is perhaps due to the maintenance of high tissue water content.

References

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