Physiological Responses Of Grafted Tea (*Camellia sinensis* L.) To Water Stress

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A Thesis submitted in fulfilment for the Degree of Doctor of Philosophy in Horticulture

in the Jomo Kenyatta University of Agriculture and Technology

2008

ABSTRACT

Currently, tea planting is expanding towards areas that are marginally dry for economic tea production and accompanied by reduced tea quality. Use of grafted materials in such areas may offer certain potentials depending on the drought tolerance of the rootstocks used. The rootstocks used in the experiments were tolerant to water stress, while the scions were high yielders and good quality. An assessment of physiological responses of composite tea to water stress and critical soil moisture level offers an identification of traits that could be used as criteria for selection of drought tolerant rootstock-scion combination.

A field experiment was set up at Kipkebe Limited, Sotik and two others inside a rain out shelter (a semi-controlled environment) at the Tea Research Foundation of Kenya, Kericho, to evaluate the physiological responses and yields of grafted tea to water stress.

Results showed that water stress significantly ($P<0.05$) reduced stomatal conductance (G_s), net CO_2 assimilation (A) and transpiration (E). High G_s by scion clones on rootstocks EPK TN 14-3, TRFK 57/15 and TRFK 303/577 suggested high tolerance to water stress. The water stress significantly ($P<0.05$) shifted the dry matter (dm) partitioning, with more dm being allocated to roots in stressed treatments. There was a significant ($P<0.05$) reduction in shoot: root ratio, leaf area and stem diameter ($P<0.03$) with water stress. However, water stress increased root length per unit volume of soil density. Reducing soil moisture contents led to higher concentration of chlorophyll contents possibly due to reduced leaf expansion, but

decreased leaf water potential and relative water content. Diurnal variation was also evident in the leaf water potential, with lower values recorded at midday.

There were significant differences in air temperatures, saturation vapour pressure deficit and soil water deficit within and between the year(s) in the field site. These variables affected the yields obtained. Yields decreased (R^2=0.74***) with increase in potential soil water deficit and clonal variation was evident with scion AHP S15/10 having a decrease of 0.97 kg mt/ha/week (mm SWD)$^{-1}$. Grafting significantly (P<0.05) depressed the yield of the tested scion varieties, which decreased with increase in rootstock ploidy. There was a small margin in yield increases on scions grafted on diploids rootstocks. The triploids and tetraploid rootstocks depressed the yield of most scions. The water use efficiency (WUE) significantly (R^2=0.86***, 0.72***) varied and was in the ascending order of diploids>triploids>tetraploids rootstocks, for 2003, and 2004, respectively. Shoot density, development and compositions were varied between seasons, rootstock ploidy and scions. The shoot parameters contributed to varying yield levels as influenced by soil water deficits, air temperatures and saturation vapour pressure deficit.

The total chlorophyll content varied between clones and decreased significantly (P<0.05) with increase in soil moisture content. Rootstocks did not affect the chlorophyll content. The differences in chlorophyll content between clones significantly reduced the photosynthetic capacity. The reduced soil moisture content reduced the leaf water potential in all the clones. The diurnal differences in leaf water potential were more pronounced at the 12.5% v/v soil moisture content.

Generally, the mean leaf water potential increased with a decline in soil moisture content. Based on this study, the minimum moisture level below which composite tea plants might suffer water stress is below 30% v/v, and the exposure period should be short. Rootstocks identified as being potential for commercialisation are TRFK 57/15, TRFK 8/112, TRFCA SFS 150 and EPK TN 14-3. Among the scions, AHP S15/10 was found to be more susceptible to water stress. Relative water content declined with decrease in soil moisture content (R^2= 0.9915, $P<0.001$) in all the scions. Both relative water content and leaf water potential could effectively be used as water stress indicators in composite tea.

These results and effects were varietal dependent and are discussed in detail. The results point out the implications of the studies to the Kenyan tea industry bearing in mind that there may be increased frequencies of dry seasons resulting in high soil water deficits and hence decline in tea yields. The magnitude of the decrease depends on the range of soil water deficit and duration.