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Drought Stress Imposed at Different Reproductive Stages Influences Growth, Yield and Seed Composition of Soybean

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Soybean (*Glycine max* L.) was grown in 2003 and 2004 to determine the effect of deficit irrigation given at five different reproductive stages on its growth, yield and seed composition. All soybean plots received full irrigation during the vegetative stage, while treatments were started during one of the reproductive stages (R_{1-2}, beginning of flowering and full bloom; R_3, beginning of pod; R_4, full pod; R_5, beginning of seed; R_6, full seed and full irrigation) by completely stopping irrigation. In 2003 and 2004, the observed leaf area index ranged from 3.9 (R_6) to 2.6 (control), and from 4.0 (R_6) to 2.7 (control), respectively. Water stress resulted in reduced vegetative growth, leaf relative water content and leaf chlorophyll content. In 2003 and 2004 seed yields ranged from 1955 (R_6) to 3684 kg ha^{-1} (control), and from 1867 (R_6) to 3952 kg ha^{-1} (control), respectively. Any water stress imposed on soybean plants in R_3, R_5 and R_6 resulted in substantial yield reduction compared with the full irrigated control treatment. There were no significant effects of total chlorophyll and leaf relative water content on the oil and protein content of soybean seed. Water stress during the different reproductive stages (R_1–R_6) significantly affected protein content, C18:0, C18:2 and C18:3 fatty acids. The lowest protein value was obtained in R_{1-2}, while the highest values were obtained from R_4 in both years. Water stress effect imposed on any of the reproductive stages showed a significant effect on protein content but not seed oil. The highest protein content values were obtained from R_4 treatment at 42.5% and 42.1% in 2003 and 2004, respectively, while the lowest values were from R_5 and R_{1-2} at 37.9% and 38.9% in 2003 and 2004, respectively. Average seed oil content in 2003 and 2004 were 14.61% and 16.12%, respectively.

Key Words: water stress, reproductive stages, soybean, oil, protein, semi-arid climatic conditions

Abbreviations: DM – dry mass, FM – fresh mass, LAI – leaf area index, LRWC – leaf relative water content, RS – reproductive stage, TM – turgid mass

INTRODUCTION

For sustainable agriculture, the preservation of fresh water sources plays a crucial role since it has one of the biggest effects on agronomic crop growth and quality parameters. Increased demand for fresh water sources makes it necessary to save as much fresh water as possible. Since agriculture alone uses about 80–90% of fresh water sources, much of the stress is on agricultural water users. In general, depending on the level of reduction, deficit irrigations usually result in reduced agronomic crop quality and growth (Karam et al. 2005).

Soybean (*Glycine max* L.) is one of the world's most important sources of high quality plant proteins and vegetable oils. Soybean quality is determined by oil and protein content. Soybeans are an economical and valuable agricultural commodity because of their unique chemical composition. Among cereal and other legume species, soybean seeds contain the highest amount of protein and a relatively high level of oil (Boydak et al. 2002). Soybean