DROUGHT RESISTANCE IN AMARANTH & AFRICAN LEAFY VEGETABLES

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ABSTRACT

Amaranth (*Amaranthus* spp.) is a drought resistant crop widely grown and consumed for its nutritious leaves in East Africa. The goal of this research was to characterize differences in drought response among four varieties of vegetable amaranth grown in this area: AC45, AM38, ExZan, and ExZim, including their response at different stages of vegetative development. All varieties were exposed to both short term and long term stress while plant responses were evaluated. Under short term drought stress (up to 8 days without water) one variety, ExZim, showed the least effects of water stress in terms of biomass reduction. Under long term drought stress, ExZan was the only variety with significant reductions in both dry weight and leaf area. Drought stress had the greatest negative impact on biomass production at later stages of development (20-25 node growth period). These considerations can help growers select appropriate amaranth varieties to help budget scarce water resources and preserve yield.

MOTIVATION

Food security is a combination of access, availability, and utilization of nutritious food. Kenya faces many challenges to food security, including erratic rainfall that can limit food production to unreliable and brief rainy seasons. Drought resistant varieties have the potential to extend the growing period and provide increased yields and greater profits for growers. African Leafy Vegetables (ALVs), including amaranth, are an important set of crops in Kenya, both as a source of micronutrients (Orech et al. 2007) and an income generating opportunity, especially for women (Weinberger et al. 2011). Identifying germplasm that exhibits drought resistant characteristics will increase the resilience of agricultural systems in this region of the world.

HYPOTHESIS AND OBJECTIVES

Hypothesis

Differences in drought resistance exist between cultivars of amaranth

Objective: Assess drought tolerance across three main types of water stress

1. Acute stress (short term)
2. Chronic stress (long term)
3. Developmental stages (vegetative development)

METHODS

1) Acute stress experiment
   - Four varieties: AC45, AM38, ExZan, ExZim
   - Water withheld for 0 (control), 2, 3, 4, or 5 days
2) Chronic stress experiment
   - Four varieties: AC45, AM38, ExZan, ExZim
   - Treatments: plants maintained at 0.40 (watered) and 0.10 (drought) m^3/ m^3 soil water content
   - Treatments initiated at 3 weeks, harvested every 2 weeks thereafter for a total of 9 weeks
3) Developmental stages experiment
   - 60 plants of a single amaranth variety (AHTL) were subject to water stress at three different vegetative stages (Table 1)

Vegetative Stage	10-15 nodes	15-20 nodes	20-25 nodes
Control	90% WHC	90% WHC	90% WHC
Treatment 2	**30% WHC**	90% WHC	90% WHC
Treatment 3	90% WHC	**30% WHC**	90% WHC
Treatment 4	90% WHC	90% WHC	**30% WHC**

Table 1. Stages of vegetative development at which water stress was imposed.

RESULTS

Experiment 1 – Acute stress

- ExZim lowest yielding in watered treatments but least affected by water stress (Figure 1)
- AC45, AM38 and ExZan high yielding in watered treatment but rapidly impacted by water stress (Figure 1)

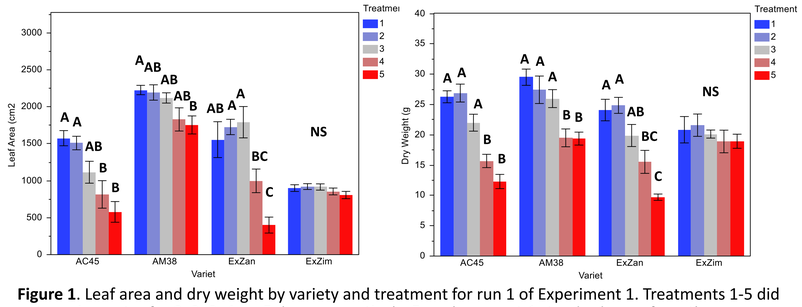

Figure 1. Leaf area and dry weight by variety and treatment for run 1 of Experiment 1. Treatments 1-5 did not receive water for 0, 2, 3, 4, or 5 days, respectively. Error bars are ± 1 standard error from the mean. Bars not connected by a common letter are significantly different.

RESULTS

Experiment 2 – Chronic Stress

- Most negative impacts of water stress in ExZan (Figure 2)
- Water stress impacted leaf area in AM38 and ExZim before dry weight was compromised
- AC45 showed no significant negative effects

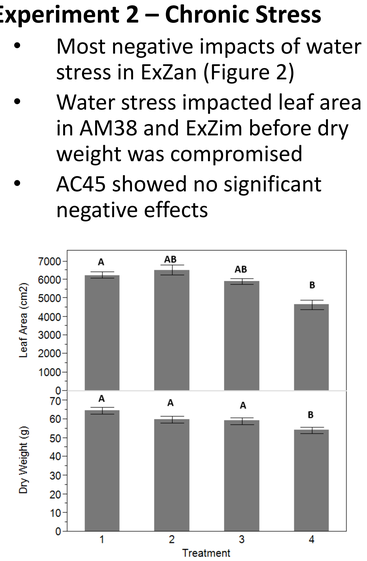

Figure 3. Leaf area and dry weight by treatment for Experiment 3. Error bars are ± 1 standard error from the mean. Bars not connected by a common letter are significantly different.

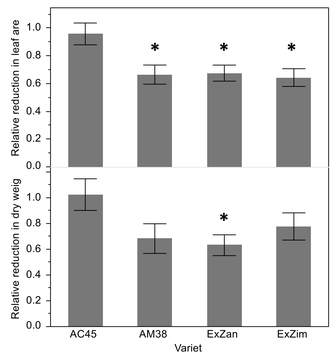

Figure 2. Relative reduction in leaf area and dry weight by variety and treatment for Experiment 2. Asterisks indicate significant differences from the control treatment. Error bars are ± 1 standard error from the mean.

Experiment 3 – Developmental Stages

- Largest impact of drought stress was on older plants (20-25 node stage)

CONCLUSIONS

- These varieties of amaranth showed tolerance for both acute and chronic water stress
- Varieties adapted to short term water stress are not the same varieties that survive long term water stress
- Drought stress late in vegetative development more negatively impacts biomass production than earlier vegetative stages in amaranth
- These results can help growers budget water resources and preserve yield even in times of water stress. Planting more drought resistant crops such as amaranth may help improve the resilience of agroecosystems in the face of climate change

REFERENCES

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