Effect of Cover Crops and Nitrogen Fertilization on Juice Yield, Sugar Content and Biomass Yield of Sweet Sorghum

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Abstract: The purpose of the study was to analyze the effect of cover crops and nitrogen fertilization on sweet sorghum biomass yield, amount of juice produced and sugar components in the juice (sucrose fructose and glucose) when grown on a marginal land. The sweet sorghum was planted in 2013 at Fort Valley State University research farm with 4 cover crops (control, rye, vetch and rye& vetch mix) and 2 nitrogen rates (control vs 90 kg /ha) with 3 replications. Juice was extracted from 20 plants per plot. The extracted juice was analyzed for sucrose, glucose and fructose using high performance liquid chromatography (HPLC). The analysis of variance (ANOVA) for role of nitrogen fertilizers showed no significant difference between control and 90 Kg N/ha for biomass yield, juice yield, sucrose, glucose and fructose content. Cover crops when compared with no cover crops, showed no significant difference. Biomass yield was found significantly different only for vetch and rye treatments. In addition, when sugar components were analyzed with respect to quantity of juice produced, no significant relationship was observed in terms of quantity of individual components. The results seems promising that sweet sorghum can be grown on marginal land in absence of cover crops and nitrogen fertilization without impacting biomass yield, amount of juice produced and sugar content in the juice. Further research is needed to validate the findings.

Introduction:

Sweet sorghum (*Sorghum bicolor* L. Moench) (Fig.1), a C4 plant, has high photosynthetic efficiency and biomass and sugar yielding ability (Wu *et al.*, 2008). Sweet sorghum is often considered to be one of the most drought resistant agricultural crop as it has the capability of remaining dormant during the driest periods (Woods, 2000). The plant height ranges from 120 to 400 cm, depending on the variety and growing conditions. It can be an annual or short perennial crop (Wu *et al.*, 2008). Sweet sorghum can be cultivated in both temperate and tropical regions, has one-third the cost of cultivation compared to sugarcane is easier to grow, harvest and transport, and uses significantly less water (Matsika and Yamba, 2006).

Legumes fix atmospheric N that can be utilized by the succeeding crop. Leguminous cover crops vetch (*Vicia villosa* Roth) and annual rye (*Secale cereale* L.) are well adapted to southern US (Sainju *et al.*,2002). Sainju and Singh (2008) reported that 71 to 108 kg/ha/year gain in soil N at 0 to 30 cm as a result of legume cover crop in cotton and sorghum production. Other benefits of cover crops are reduced weeds, pests, and diseases, improved soil aggregation and water holding capacity, and increased soil quality and health. Nitrogen has a significant role on plant growth through cell division (Saraswathy *et al.,* 2007). Nitrogen fertilizer promotes sucrose content, protein percent and growth rate in sweet sorghum (Tsialtas and Maslaris, 2005).

Role of cover crops and N fertilizer just after converting fallow to cultivable land is one of the aspect not given proper attention. Further, sufficient literature is not available for sugar component of crop in such scenario.

Objectives:

- Determine the effect of nitrogen fertilization and cover crops on juice, sugar, and biomass yield of sweet sorghum
- To analyze the relation between juice quantity and sugar components of sweet sorghum

Materials and Methods:

Field experiments were conducted at Agricultural Research Station, Fort Valley, GA on marginal land previously maintained as pasture. The experimental design used for the experiment was split plot with three replications. The main plots comprised of four winter cover crop treatments, viz., control, hairy vetch (Fig. 2), annual rye (Fig. 3), and hairy vetch + annual rye (Fig. 4). The sub-sub plots were fertilized at 0 and 90 Kg N/ha. Cover crops were drilled in the fall and harvested in late April. Photoperiod sensitive sweet sorghum EJ7281 was planted in early May in plots of four 12 m long rows spaced 0.76 m apart. Fresh weight of the plant was measured immediately after harvest and dry weight was taken after drying at 60^{0}C temperature until constant weight was achieved. The juice was extracted from 20 random samples from each plot. The extracted juice was analyzed for sucrose, glucose and fructose using high performance liquid chromatography (HPLC). The retention time in chromatography was 8.483, 10.251 and 11.308 minutes for sucrose, glucose and fructose respectively.

Figure 1


Figure 2


Figure 3


Figure 4


Results:

- There was no significant difference in biomass and juice yield in comparison to control either with the use of cover crop or nitrogen fertilization (Fig. 5 i, ii, iv and v). Rye has shown significantly higher biomass yield than vetch but was at par with control. No significant changes were observed in the biomass and juice yield with the combination of rye and vetch (Fig. 5 iii and vi).
- There was no effect of cover crops and nitrogen fertilization on sucrose glucose and fructose content in juice samples (Fig. 7).
- Quantity of juice produced had no significant impact on the quantity of analyzed sugar content (sucrose, glucose and fructose) (Fig. 6).

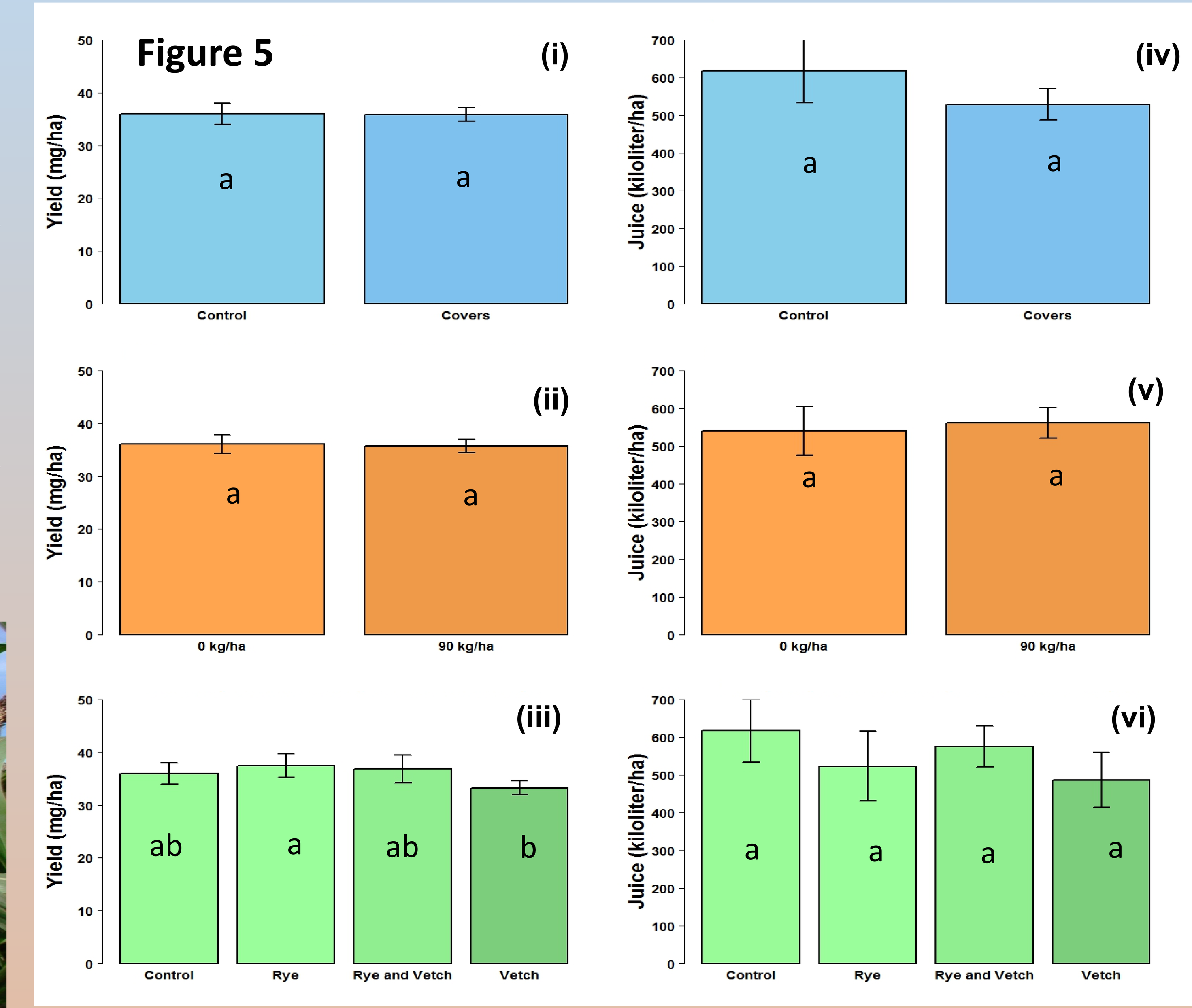
Figure 5


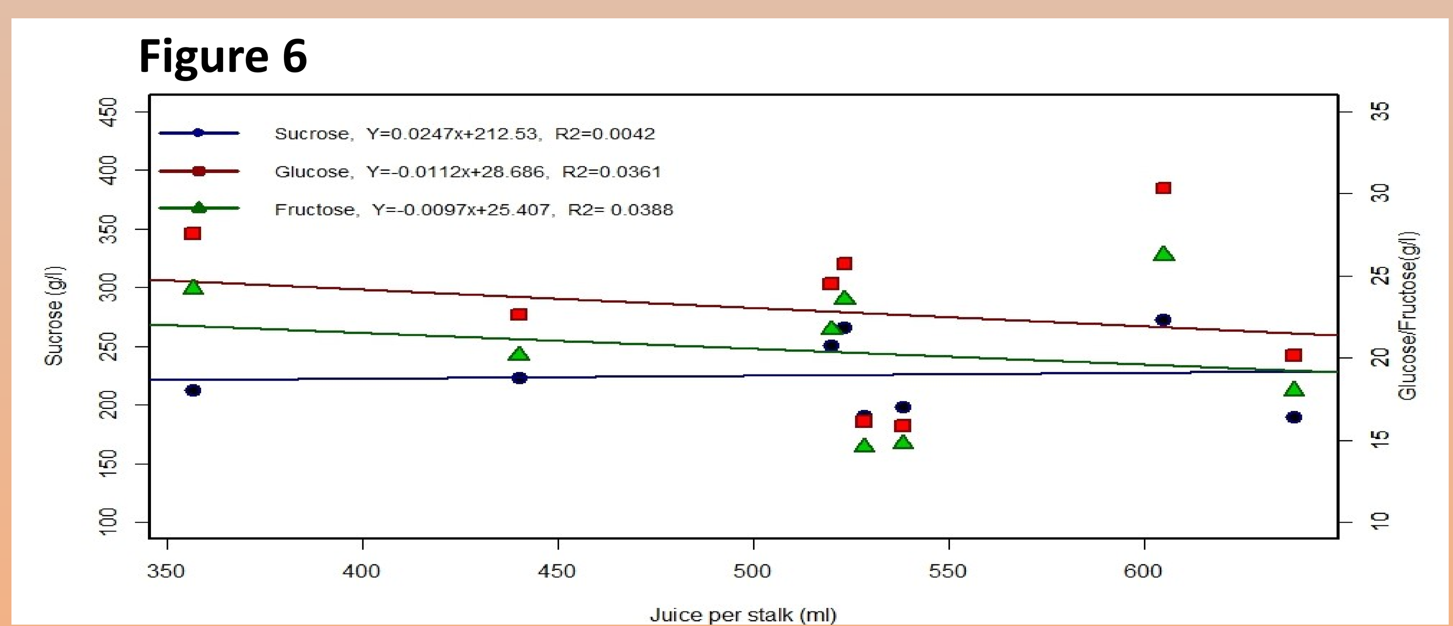
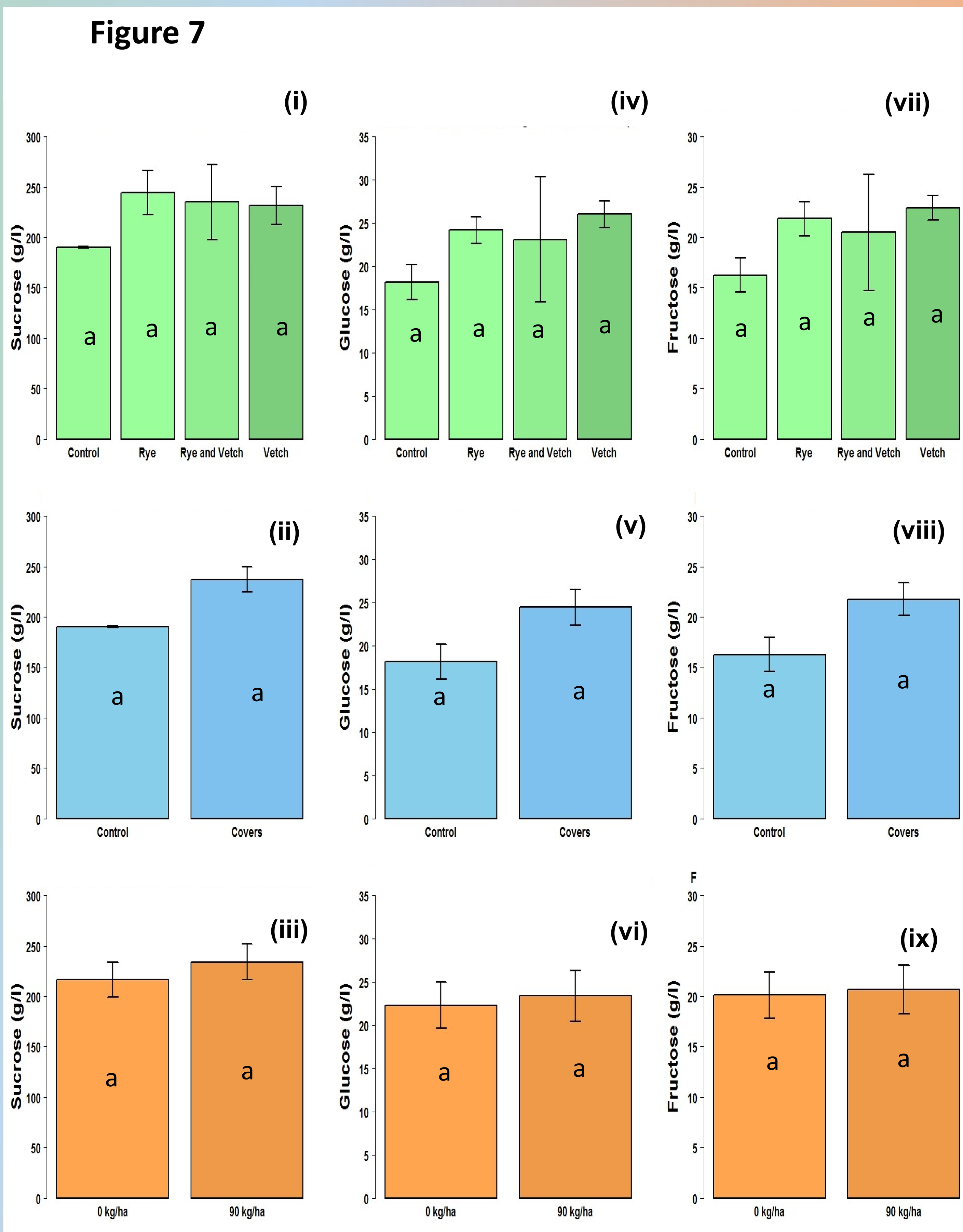
Figure 6


Figure 7


Conclusions:

- Nitrogen fertilization and cover crops did not show any significant impact on juice, sugar, and biomass yield of sweet sorghum compared to control when planted in marginal fallow land.
- No relationship between juice quantity and sugar components of sweet sorghum was evident from the data.
- It seems that sweet sorghum can be grown on marginal land in absence of cover crops and nitrogen fertilization without impacting biomass yield, amount of juice produced and sugar content in the juice.
- Further research is needed with multiple year data to validate the findings.

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