Water use efficiency in sorghum-pigeonpea diversified cropping systems in marginal areas of Ghana and Mali

Princess Adjei-Frimpong[1], Sieg Snapp[2], Eva Weltzien[3], Saaka Buah[4]
[1, 2] Plant, Soil and Microbial Sciences Department, MSU [3]International Crops Research Institute for Semi-Arid Tropics (ICRISAT), Mali [4]CSIR-Savanna Agricultural Research Institute, Wa,Ghana.

Introduction

- Water use efficiency (WUE) is an important determinant of crop productivity in water limited environments
- Seasonal rainfall variability , diversity in soil and crop types, and soil nutrient levels influences crop water use and overall crop yield
- Cereal-legume association have been shown to improve WUE due to differences in rooting pattern of component species resulting in complementary resource use
- Pigeonpea, a semi-perennial legume has the hydraulic lift potential which makes the crop adaptable to highly variable rainfall conditions
- However, it is not well established whether pigeonpea is able to hydraulically lift water as a sole crop or as intercrop, and whether this water lifting makes the plant water use efficient

Hypothesis

- Sorghum-pigeonpea intercrop increase water use efficiency relative to sole cropped sorghum by reducing soil moisture competition between the plant species due to spatial differentiation in roots and the hydraulic lift of pigeonpea

Objectives

1. Determine the soil moisture distribution in the root zone of sorghum and pigeonpea
2. Assess the effect of cropping system and soil nutrient on sorghum-pigeonpea yields and water use efficiency

Materials and Methods

Experimental Design

- Field experiments were set-up in three different agro-ecological zones in Ghana and Mali , during the 2015 cropping season
- Randomized complete block design , 4 replications with two cultivars of pigeonpea, long and medium duration and sorghum was planted as intercrop and sole crop
- Intercrop system was an 'additive design'

Cropping system treatments

- The experiment had 10 and 12 treatments respectively, but 5 treatment sets was used for soil moisture monitoring

1. Sole pigeonpea, medium duration
2. Sole pigeonpea, long duration
3. Sole sorghum
4. Sorghum-pigeonpea intercrop, medium duration
5. Sorghum-pigeonpea intercrop, long duration

Nutrient management

1. Low fertility- no fertilizer was applied, only organic manure
2. High fertility – organic manure + fertilizer

- Diammonium phosphate (DAP) at 100kg/ha before ridging
- Urea at 50kg/ha after the second weeding

Access tube installation

- Access tubes were installed within rows of each plot to a depth of 100 cm in all treatments
- The installed access tubes were used to measure the volumetric water content changes during the crop growth
- One access tube installed per treatment plot

Figure 1. Access tube installation

Soil moisture monitoring

- Soil moisture content was monitored at different stages of plant growth during the growing season
- The first measurement was taken at planting
- Soil water content was measured at incremental depths of 0-10 cm, 10-20 cm, 20-40 cm, 40-60 cm, and 60-100 cm using the Time domain reflectometry (TDR) profile probe type PR2

Figure 2. Soil moisture reading using TDR

Data collection and analysis

- Leaf chlorophyll content at vegetative, flowering and physiological maturity
- Grain yield and biomass assessment (vegetative, flowering and physiological maturity stages of crop growth)
- Data will be analyzed using SAS and means will be separated using LSD (0.05)

Figure 3. Sorghum-pigeonpea intercrop

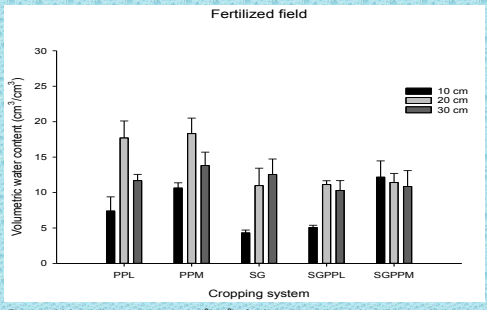

Figure 4. Volumetric water content (cm^3/cm^3) of sole and intercropped sorghum and pigeonpea at 45DAP. PPL= long duration pigeonpea, PPM= medium duration pigeonpea, SG= sorghum, SGPPL= sorghum-pigeonpea intercrop (long duration), SGPPM= sorghum-pigeonpea intercrop (medium duration)

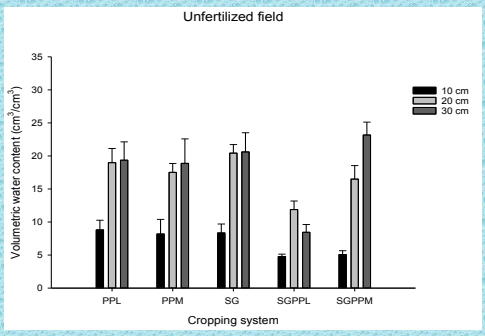

Figure 5. Volumetric water content (cm^3/cm^3) of sole and intercropped sorghum and pigeonpea at 45DAP. PPL= long duration pigeonpea, PPM= medium duration pigeonpea, SG= sorghum, SGPPL= sorghum-pigeonpea intercrop (long duration), SGPPM= sorghum-pigeonpea intercrop (medium duration)

Preliminary Results

- Volumetric water content in the unfertilized field was relatively higher than the fertilized field (Fig.5)
- The general trend observed was high water use under the intercrop system

Acknowledgements

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