Radiation Use Efficiency, Forage Yield and Quality of Sorghum-Legume Intercropping Systems in the Southern High Plains

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INTRODUCTION

Interest in intercropping of non-legume with legume crops as a crop production method to increase the efficiency of resources use is increasing. Water and radiation are the main plant growth limiting factors for crop production. Forage sorghum is more drought tolerant compared to commonly grown corn. However, forage yield and quality of sorghum is lower than corn. Inter-row spacing, which is at least 75 cm in a typical forage corn or sorghum production systems in the region, is usually unused by the sole cropping systems until the canopy closure (50-60 days after planting). Growing an annual legume in inter-row space could improve radiation interception, radiation use efficiency, forage quality and yield.

Objectives:

- Assess seasonal radiation interception and radiation use efficiency (RUE) of sole-sorghum and sorghum + legume intercropping systems
- Compare seasonal forage dry matter yield and quality of sole-sorghum, sorghum + legume intercropping systems

MATERIALS & METHODS

Location:	Agricultural Science Center at Clovis, NM
Intercropping: Systems	Sole-sorghum, sorghum-lablab bean and sorghum-pole bean
Planting date:	31 July 2008 and 1 July 2009
Row spacing:	75 cm sorghum rows (legumes were planted in the middle)
Seeding rates:	8.2 Kg ha^{-1} for forage sorghum cv. FS-5; widely grown in the area, 38.0 Kg ha^{-1} for lablab bean cv. Rongai 66.5 Kg ha^{-1} for pole bean cv. Genuine corn field
Design:	RCBD with 4 replications
Irrigation:	Surface drip (2008) and Center pivot (2009)

Data collection:

- Photosynthetically Active Radiation (PAR) and leaf area index (LAI) were measured with a Sunscan Canopy Analyzer System (a 1m long linear SunScan probe for measuring PAR at ground level and a Beam Fraction Sensor mounted on a tripod (model BF2) for incident PAR).
- Intercepted PAR was the difference between incident PAR and the PAR transmitted through the canopy to ground. The fraction of radiation intercepted (FIPAR) was calculated as the ratio of radiation intercepted by the plants to incident PAR.
- Daily solar radiation data were obtained from the weather station located within 200m from the trial. The daily incident PAR was assumed equal to 0.45 times the daily incident solar radiation (280-2800 nm). The interpolated FIPAR data were then used with the daily solar radiation data to calculate the daily IPAR. Then IPAR was accumulated for each day of each harvest interval (one day after planting to each harvest).
- Radiation use efficiency (RUE) was calculated as the chemical energy stored (biomass) to radiant energy intercepted by plants. Radiation use efficiency (g MJ^{-1} of IPAR) for each harvest was calculated as [(cumulative biomass of each harvest minus initial cumulative biomass, g m^{-2})/ (cumulative PAR of each harvest minus initial cumulative PAR, MJ m^{-2}).
- Plants were harvested for seasonal dry matter accumulation. One row of sorghum and one row of bean plants (0.225m^2 in 2008 & 0.285 m^2 in 2009) and 2 rows of sorghum and 2 rows of beans (1.5 m^2) were harvested at final harvests in both 2008 and 2009
- Plant materials of individual crops were analyzed for forage quality parameters including Crude protein (CP) using NIR method.

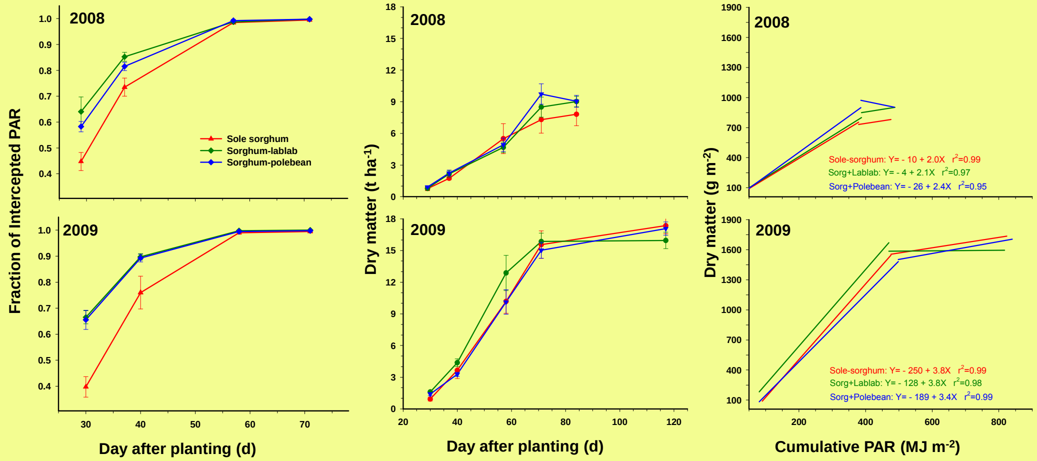

Fig. 1. Seasonal patterns of radiation interception (left), dry matter accumulation (center), radiation use efficiency (right) of sorghum-legume intercropping systems in comparison to sole forage sorghum at Clovis, NM in 2008 and 2009. Vertical bars are standard error of means ( ). Slope of regression fitted to the linear portion of cumulative intercepted radiation (MJ m^{-2}) and DM relationship is the radiation use efficiency.

RESULTS

In 2008, due to hail damage the trial was replanted very late on July 31. The trial was also harvested early due to early fall frost. Results are preliminary.

- Adding a legume crop as an intercrop in general improved radiation interception early in the season. By 60 days after planting the advantage of intercropping to intercept radiation ceases.
- Early in the season, improved radiation interception by legumes contributed to >25% of biomass by legume crops (data not presented). Legume contribution gradually decreased to ≈10% at harvest.
- Forage yield (DM) tended to be higher early in the season with intercropping. But at harvest there was no significant difference.
- Radiation use efficiency during the rapid vegetative growth seem to benefit from intercropping, but the differences were small. Two legumes used in the trial responded different in two contrasting years.
- Forage quality analysis indicated potential of legumes in improving many forage quality parameters including crude protein (data not presented). Legume contribution to the final forage harvest needs to be improved to realize quality benefits.

Fig. 2. Comparison of ground cover under sole sorghum (left), sorghum+pole bean (middle) and sorghum+lablab (right) intercropping systems around 50 days after planting at Clovis 2009.

Fig. 3. Measurement of incident PAR using beam Fraction Sensor (tripod mounted) and intercepted PAR with linear SunScan probe (Clovis 2009).

Fig. 4. Intercropping of forage sorghum cv. FS-5 and lablab cv Rongai at harvest in Clovis 2009.

Summary

Forage sorghum and legume intercropping system has potential in the Southern High Plains to improve resource use efficiency, productivity and forage quality. Legumes tried, lablab cv. Rongai and pole bean cv. Genuine Corn Field, were quite promising. More work is needed to reduce intercrop competetion, improve legume contribution, identify suitable crops and cultivars.

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