

Effect of Intercropping Three Legume Species on Early Growth of Sweet Corn (*Zea mays*)

Amjad A. Ahmad, Theodore J.K. Radovich, and Nguyen V. Hue

Introduction

Intercropping is the growing of two or more crops simultaneously on the same field (Sangakkara et al., 2003). Intercropping can be used by small farmers to increase the diversity of their product and the stability of their annual output through effective use of land and other resources (Khan et al., 1999). Legumes are known to fix atmospheric nitrogen, thus enriching soil fertility, and helping to meet the N needs of cereals (Manna et al., 2003).

Intercropping is used in many parts of the world for the production of food and feed crops (Dasbak and Asiegbu, 2009). Successful, intercropping corn and soybean has been reported since the early

1900s in North America and since soybean meal is often used to increase the typically low (6-9%) protein content of corn silage, it is reasonable to grow corn and soybean together, and much work has been done on corn-soybean model (Geren, et al., 2008). However, there are significant gaps in the literature regarding the effect of different species of legume crops. Sangakkara et al. (2003) studied the effect of intercropping beans (*Phaseolus vulgaris* L.) and Sunhemp (*Crotalaria juncea* L.) with corn (*Zea mays* L.) under humid tropical condition of Sri Lanka on growth, yield and nitrogen content of maize in a long term study. They found a significant increase in the studied variables, especially during the latest seasons of their experiments, in maize biomass, yield, and leaf nitrogen content. Manna et al. (2003) found that intercropping maize with legumes (pea, *Pisum sativum* L.), pigeonpea (*Cajanus cajan*), and soybean (*Glycine max* L. merril) was good strategy to significantly increase maize productivity. Also, they found some legume species performed better than others. This study was conducted to examine the effect of intercropping different legume species on growth, and relative chlorophyll content of sweet corn.

Material and Methods

Two field trials were conducted at the University of Hawai'i Mauka Campus Experiment Station, at Mānoa, O'ahu in Randomized Complete Block Design (RCBD) with four blocks for two consecutive growing seasons. Individual plots measured 8.5 ft x 7.5 ft. The space between the



Fig 1. Sweet corn intercropped with cowpea was greener than the other treatments.

rows was 2.5 ft. Each plot had 3 rows of crops. Plant density was based on the recommended from previous literature (Mana, et al., 2003). Each treatment plot consisted of three rows; Data was taken from the central row with a guard row on either side. Seeds were sown in trays for 2 weeks before transplanting to the field. Urea fertilizer was broadcast without incorporation at 200 kg ha⁻¹ for the two growing seasons. Seedlings, for both seasons, at transplanting were: Corn, 16 cm tall with three expanded leaves; Bush bean, 20cm tall with first trifoliolate leaves emerging; Cowpea, 14cm tall with first trifoliolate leaves emerging; Soybean, 25cm tall with first trifoliolate leaves fully expanded. Drip irrigation was used during the two growing seasons. Standard weed and pest control practices were employed as necessary throughout plant development. Plant height (cm), leaf area (cm²), and relative chlorophyll content (RCC) of the second leaf from the flag leaf in all corn plants of the treatment row of each plot were measured. RCC was determined with a Minolta SPAD-502 chlorophyll meter. Due to some technical issues, we could not harvest the biomass for the first growing season. However, for the second growing season, biomass of corn and corn/legume plants in the inner row were harvested, fresh weight was recorded at harvest time, and then plants were dried for 72 hours on 75oC, and data were recorded. All collected data were subjected to analysis of variance (ANOVA) using SAS (Statistical Analysis System) and Duncan's mean separation test was performed for all significant treatments based on the ANOVA results.



Fig 2. General view of the intercropping field after 34 days of planting.

Results and Discussion

Analysis of variance of the results showed a highly significant ($p < 0.01$) effect of the legume species on plant height and RCC and significant ($p < 0.05$) effect for leaf area during the first growing season. However, during the second growing season, the results were significant ($p < 0.05$) for plant height and RCC only. Also, there was a significant effect of the intercropping treatments on corn and corn/legume fresh and dry weights. Plant height under C/P treatment, for the two growing season, was significantly higher (94.4 and 93.5 cm, respectively) than other treatments. Also, C/B and C/S treatments were significantly higher (83.7, and 80.4 cm in the first growing season, for the two treatments, respectively, and same pattern was shown in the second growing season) than the control treatment and for the two growing seasons (Table 1).

Table (1) Means and Duncan's test letters for the growth parameters during the two growing seasons under the intercropping treatments.

Treatment	First Growing Season			Second Growing Season		
	Plant height (cm)	Leaf Area (cm ²)	RCC	Plant height (cm)	Leaf Area (cm ²)	RCC
Control	76.3 ^B	301.5 ^C	25.8 ^C	73.5 ^C	289.9 ^A	24.4 ^C
Corn/Bush bean	83.7 ^B	334.2 ^B	33.1 ^B	83.6 ^B	327.4 ^A	30.9 ^B
Corn/Cowpea	94.4 ^A	401.4 ^A	43.3 ^A	93.5 ^A	398.7 ^A	40.6 ^A
Corn/Soy bean	80.4 ^B	321.3 ^B	31.1 ^B	81.1 ^B	312.1 ^A	30.5 ^B

*Means with different letters are significantly different at 5% probability, RCC = relative chlorophyll content.

Leaf area under C/P treatment, for the first growing season, was significantly higher (401.4 cm²) than other treatments. Also, C/B and C/S treatments were significantly higher (334.2 and 321.3 cm², respectively) than control treatment (301.5 cm²), in the first growing season (Table 1). The increase in leaf area might be related to the increase in RCC in corn leaf tissue as explained by the positive significant correlation (Fig 3) between the two parameters (Wiatrak, et al., 2011).

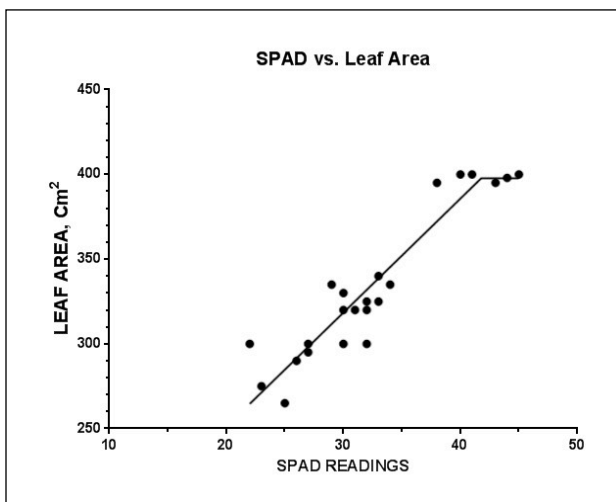
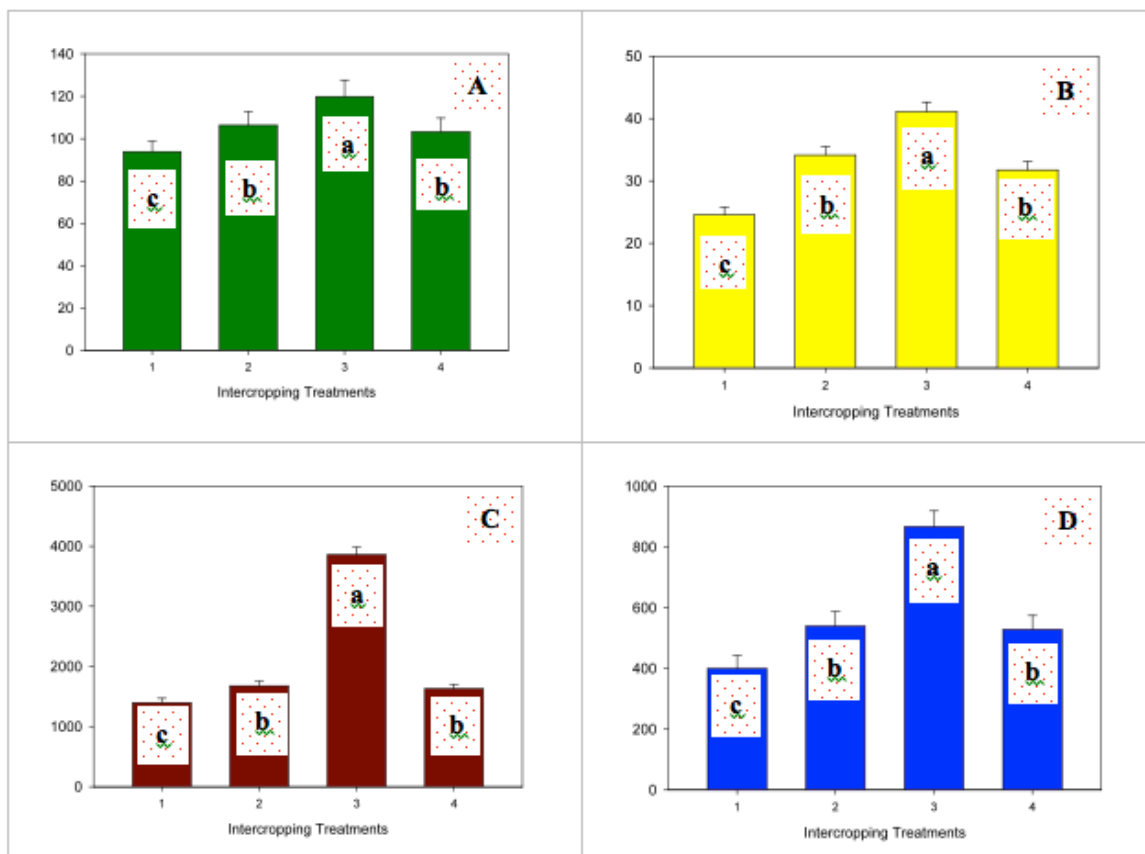


Fig 3. Regression of relative chlorophyll content against leaf area for the combined data of both growing seasons.

Relative chlorophyll content (RCC) under C/P treatment, for the two growing season, was significantly higher (43.3 and 40.6, respectively) than other treatments. Also, C/B and C/S treatments were significantly higher (33.1, and 31.1 in the first growing season, for the two treatments, respectively, and 30.9 and 30.5 in the second growing season, for the two treatments respectively) than the control treatment and for the two growing seasons (Table 1). RCC is known to be positively correlated with soil fertility, the slightly decline in RCC content, during the second growing season, might be related to the decline in soil fertility during the second growing season (Martin, et al, 2007; Haghighi, et al., 2010; Ahmad et al, 2012).

Sweet corn and corn/legume fresh and dry weights were all significantly higher under the C/P treatment compared to the other intercropping and control treatments (Fig. 4: A-D). Individual corn plant fresh weight under the C/P treatments increased by 12.8, 16.1, and 27.7% compared to C/B, C/S, and C/0, respectively (Fig. 4: A), while dry weight of individual corn plant under the C/P treatment increased by 20.4, 29.4, and 67.0% compared to C/B, C/S, and C/0, respectively (Fig. 4: B). Also, corn ears yield (data not presented) were significantly higher under C/P compared to other intercropping and control treatments.

Fig 4. Means and Duncan's test letters for: A) corn plants fresh weight (g); B) corn plants dry weight (g); C) corn + legume biomass fresh weight (g); and D) corn + legume biomass dry weight (g), in the second growing season under different intercropping treatments.



*Bars with different letters are significantly ($p > 0.05$) different from each other according to Duncan multiple test. Treatments (Bars) are: 1 = corn alone; 2 = corn/soy bean; 3 = corn/cowpea; and 4 = corn/bush bean.

The significant increase in plant height, RCC, corn and corn/legume biomass under the C/P treatment suggests a greater contribution of cowpea, probably through the rhizobium nodulation, mainly nitrogen as compared to the other legume species.

Conclusions

Based on the growth, biomass, and yield parameters collected during the two growing seasons, it appeared that greater nitrogen was available to maize intercropped with cowpea (Fig 5) than to maize intercropped with the other two legumes. The results were likely due to superior nodulation of the tropical *Vigna* sp. by native rhizobia relative to the temperate *Glycine max* and *Phaseolus vulgaris*.

This suggests that selecting intercrops that are best adapted to the growing environment (soil type, temperature, rhizobium strains) would have the most positive effect on the companion crop by minimizing competition. It was also likely that the corn in the CP treatment was directly benefiting from the N fixed by the cowpea.



Fig 5. Corn/Cowpea biomass and yield were much greater than other intercropping and control treatments.

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