RECOVERY OF COTTON (*GOSSYPIUM HIRSUTUM*) FROM INTERCROPPING SUPPRESSION BY BEANS (*PHASEOLUS VULGARIS*)

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Abstract

The performance of cotton (cu. SATU-85) grown in five intercropping systems: cotton and beans (cu. K-20) planted simultaneously (C_1L_1); cotton planted two or four weeks prior to beans (C_1L_2 and C_1L_4); and beans planted two or four weeks prior to cotton (L_1C_2 and L_1C_4 respectively), were compared with monocropped cotton C_1, C_2 and C_4 planted on different dates at two weekly intervals was studied during the growing season of 1990 and 1993 in Uganda.

Intercropping significantly ($P \leq 0.05$) reduced cotton plant height, and number of monopodia and sympodia. At cotton picking time, after the bean harvest, no significant difference was observed in number of cotton bolls under the different cropping systems. Intercropping cotton with beans simultaneously increased the number of total fruiting positions (TFPs) compared with monocropped cotton. Seed cotton yields from the different cropping systems were 2045, 2250, 2220, 2691, 1982, 2036, 1708 and 2090 kg/ha for C_1L_1, C_1L_2, C_1L_4, C_1, L_1C_2, C_2, L_1C_4 and C_4, respectively. Highest land equivalent ratios (LER) occurred when cotton was planted two weeks after beans (1.71), four weeks after beans (1.53) and simultaneously with beans (1.32) whereas planting cotton two or four weeks before beans gave the lowest LERs (1.07 and 1.03 respectively). Intercropping cotton and beans is, therefore, advantageous only when cotton is either planted simultaneously or after beans.

Introduction

Cotton (*Gossypium hirsutum* L.) an important cash crop in Northern and North-eastern Uganda, is frequently intercropped with beans (*Phaseolus vulgaris* L.), a very important crop in the region. Other food crops commonly intercropped with cotton are soybeans (*Glycine max.* L.), maize (*Zea mays* L.) and cassava (*Manihot esculenta Crantz*). The advantages of intercropping are claimed to include provision of favourable microclimate, better use of environmental resources, lower labour requirements, stability of yield and higher productivity per unit area (Osiru, 1982). However, the policies of the Ugandan Department of Agriculture discourages intercropping cotton. The effects of the associated crops on cotton yields have, therefore, not been quantified in Uganda.

The objective of the present research was to evaluate the performance of cotton when grown under different intercropping systems. The resulting information will be used to advise farmers on the advantages and disadvantages of intercropping cotton with food crops. This paper reports the results of a study carried out on cotton intercropped with beans, with the component crops being sown at different times.

Materials and Methods

Cotton (cu. SATU-85) was grown in 1990 and 1993 at Serere Agricultural and Animal Production Research Institute (SAARI), Uganda (33˚27'E and 1˚31'N; 1140 m ASL) either intercropped with beans (cu. K-20) or as monocrops. The climate is sub humid with a mean rainfall of 1350 mm bimodally distributed with a higher peak in April - May. There is a very hot dry season from December to March during which temperatures rise to a maximum of 35˚C. The experiment was conducted in an area with shallow, brown sandy loam soil of a quartz-schist parental material.

SATU-85 is resistant to bacterial blight (*Xanthomonas malvacearum*), grows to a height of up to 2 m where fertility is high, and matures in 4 - 6 months, depending on weather. K-20 is an early maturing bean variety (80 - 90 days) which grows to a height of 45 - 60 cm.

Under intercropping, cotton was planted at the recommended inter-row spacing of 60 cm and intra-row spacing of 30 cm and later thinned to two plants per hill. Beans were interplanted alternating with the cotton rows and at intra-row spacing of 30 cm. As sole crops, cotton and bean rows were similarly spaced at 60 cm between rows and 30 cm within rows. The plants were thinned to two plants per hill. Details of the treatment combinations studied are given below.

C_1L_1: Cotton and beans interplanted simultaneously on 29th April.
C_1L_2: Cotton planted on 29th April followed by beans two weeks later (15th, May).
C_1L_4: Cotton planted on 29th April followed by beans four weeks later (29th May).
C_1: Sole cotton planted on 29th April.
C_2: Sole cotton planted on 15th May.
L_1C_2: Beans planted on 29th April followed by cotton two weeks later (15th May).
L_1C_4: Beans planted on 29th April followed by cotton four weeks later (29th May).
C_4: Sole cotton planted on 29th May.

Other treatments studied were sole bean stands L_1, L_2 and L_4 planted on 29th April, 15th May and 29th May respectively but results of which are not reported in this paper. Plots measured 4m x 3m and the experiment was a randomized complete block design (RCBD) replicated five times in each season.

Counting of bean pods was done at harvest time. The pods were picked, dried under the sun, threshed, sorted and grains weighed for final yield assessment. Beginning 60 days after the first planting (DAFP), data on cotton was recorded monthly for number of monopodia and sympodia; squares and flowers; and for bolls, up to the period when no more new bolls were formed. At this time, the number of total fruiting positions (TFP) were counted. Abortion of fruiting bodies was computed from the expression (TFP - TB)/TFP x 100% where TB is the total number of bolls that contributed to final seed cotton yield. All Cotton was picked at six months from planting date and seed cotton yield calculated.

Partial Land Equivalent Ratios (LER) for each of the crops under intercropping system was computed as a ratio of intercropped yields of that crop to that of its sole yields when planted on the same date. Total LER, as a measure of overall intercropping advantage (Willey, 1979) was taken as the sum of the two partial LERs.

Results and Discussion

Intercropping significantly ($P \leq 0.05$) reduced cotton plant height (Table 1). For the cotton planted on 29th April the reduction in plant height appeared to be directly proportional to the extent of competition to which cotton plants were presumably subjected. Competition was probably most intense in C_1L_1 and least in C_1L_4. Competition probably resulted in suppressed growth. Intercropping also significantly ($P \leq 0.05$) reduced number of both monopodia and sympodia in cotton planted on 29th April compared to their control, but the reduction was not significant in cotton planted on 15th and 29th May (Table 1).

For all cotton planted on 29th April, intercropping with beans simultaneously increased the ability of the cotton crop to produce TFPs compared to the control and to the cotton grown under C_1L_2 and C_1L_4 systems (Table 2). Similarly for cotton planted on 15th and 29th May, intercropped cotton had more TFPs than their respective controls but differences were not significant. It is probable that the residual nitrogen fixed by the bean crop benefited the cotton crop in this respect. Presumably, the nitrogen fixing ability of beans grown under intercropped systems, as measured by it's effect on cotton TFPs in this case, tended to decrease with delay in bean planting. This might be used to explain the progressive decline of the TFPs in cotton grown under C_1L_1, C_1L_2 and C_1L_4, (318.3, 277.7 and 270.3 respectively). The apparent response of cotton to the fixed nitrogen tended to decrease with delay in cotton planting, which as a result emphasized more competition at early growth stages. This probably explains why TFPs for cotton grown under L_1C_2 and L_1C_4 systems were lower than their controls. Ewing (1918) and Wadleigh (1944) reported increased flowering and formation of fruiting bodies in cotton where nitrogen was applied.

Abortion of the fruiting bodies formed was significantly ($P \leq 0.05$) reduced with delay in cotton planting (Table 2). Intercropping did not affect abortion but the trend was towards reduced abortion with intercropping for cotton planted on 29th April. This is contrary to Saleem and Buxton (1978) who reported stimulated high rates of abortion due to competition for the available plant carbohydrates, between vegetative and reproductive growth.

Generally, cotton from all the treatments except C_1L_4, C_4 and C_2 reached peak boll production in September (120 DAFP) and then levelled off (Table 3). Cotton from C_1L_4 showed a continuous trend in boll production and this could be ascribed to the continuous benefit from residual nitrogen of the latter planted beans which also imposed minimum competition. The increasing trend in boll production by C_2 and C_4 cotton is a normal phenomenon because these were plants growing without any interspecific competition compared to L_1C_2 and L_1C_4. The ability of L_1C_2 and L_1C_4 to produce more bolls was probably checked by the already vigorous bean plants. By time of last sampling, no significant difference was realized in boll numbers of cotton grown under the different cropping systems and planted on the same date. This illustrates the ability of early planted cotton to recover from intercropping suppression resulting from the component crop.

Intercropping generally reduced seed cotton yields by the following percentages compared with the controls: 24.0, 16.4, 17.5, 2.7 and 18.3 for C_1L_1, C_1L_2, C_1L_4, L_1C_2 and L_1C_4 respectively. For cotton planted on 29th April, the control yielded significantly ($P \leq 0.05$) better than the intercropped cotton (Table 2). However for cotton planted on 15th and 29th May, yield of intercropped cotton did not significantly differ from their respective controls. Seed cotton quality was not affected by cropping systems and clean "safi" cotton contributed, on average, 95% of total seed cotton yields.

Partial LERs for both cotton and beans were less than 1 (Table 4) indicating yield reductions of both crops under intercropped systems compared to under their respective sole stands. Intercropping systems L_1C_2, L_1C_4 and L_1C_1 resulted into relatively lower yield reductions for each of the component crops. These were the same treatments from which higher intercropping advantages were obtained as shown by total LER (Table 4).

Conclusion

Beans and cotton can be successfully grown together either by first planting beans then following with cotton two or four weeks or by planting cotton and beans at the same time. All three of the above cropping systems allow cotton sufficient time to recover from the competition imposed by the beans before the onset of the peak reproductive growth. An additional advantage may be that cotton can utilise the nitrogen fixed by beans.

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Table 1. Effects of 8 cropping systems on cotton plant height and final number of monopodia and sympodia in 1993 at SAARI, Uganda.

Cropping system	Height (m)	Monopodia/m^2	Sympodia/m^2
C_1L_1	1.02c	18bc	.93b
C_1L_2	1.07bc	18bc	92b
C_1L_4	1.22ab	21ab	98ab
C_1	1.29a	23a	107ab
L_1C_2	1.04c	16c	79cd
C_2	1.03c	21ab	90bc
L_1C_4	0.78d	15c	70d
C_4	0.98c	19bc	77cd

abc: means in each column followed by the same letter(s) are not significantly different ($P \leq 0.05$, Duncan's Multiple Range Test).

Table 2. Effects of 8 cropping systems on number of fruiting positions (TFP), abortion and seed yield of cotton in 1993 at SAARI, Uganda.

Treatment	TFP/m^2	Abortion (%)	Yield (kg/ha)
C_1L_1	318a	68.5ab	2045bc
C_1L_2	278abc	66.1ab	2250b
C_1L_4	270bc	67.8ab	2220b
C_1	293ab	69.8a	2691a
L_1C_2	289ab	63.1bc	1982bc
C_2	243c	59.3cd	2036bc
L_1C_4	255bc	56.7d	1708c
C_4	237c	57.1cd	2090bc

abc: means in each column followed by the same letter(s) are not significantly ($P \leq 0.05$) different (Duncan's Multiple Range Test).

Table 3. Effects of 8 cropping systems on cotton boll number/m^2 during 4 sampling dates in 1993 at SAARI, Uganda.

Cropping system	July	August	September	October
C_1L_1	5a	48a	51abc	48ab
C_1L_2	3b	37bc	54abc	52a
C_1L_4	3b	31cd	55abc	57a
C_1	5a	34bcd	60a	55a
L_1C_2	1c	38bc	57ab	53ab
C_2	1c	44ab	48bc	52ab
L_1C_4	0d	16e	44c	43b
C_4	0d	26de	44c	48ab

abc. means in a column followed by the same letter(s) are not significantly ($P \leq 0.05$) different (Duncan's Multiple Range Test).

Table 4. Partial LERs for beans and cotton and total LERs for 5 intercropping systems in 1993 at SAARI, Uganda.

Intercropping system	Partial LER		Total LER
	Beans	Cotton	
C_1L_1	0.56a	0.76b	1.32bc
C_1L_2	0.26b	0.83ab	1.09cd
C_1L_4	0.21b	0.82ab	1.03d
L_1C_2	0.74a	0.97a	1.71a
L_1C_4	0.71a	0.82ab	1.53ab

abc. Means followed by the same letter(s) are not significantly ($P \leq 0.05$) different (Duncan's Multiple Range Test).