Effect of Time of Planting Cowpea (*Vigna unguiculata* (L.) Walp.) Relative to Maize (*Zea mays* L.) on Growth and Yield of Cowpea

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Keywords: Cereal/legume intercropping- Land equivalent ratio- Yield benefit- Uganda

Summary

Field investigations were carried out for three seasons in two locations of Uganda to examine yield benefits when cowpea and maize are planted under intensive farming conditions. Additive mixtures of cowpea were planted into maize thrice at 2 weekly intervals together with sole crops. Time of introducing cowpea into maize significantly affected both the growth and yield of cowpea. Simultaneous planting generally showed a yield advantage (LER> 1) of the cowpea/ maize intercropping systems irrespective of the cowpea varieties used, but LER declined when time of introducing cowpea into maize was delayed being as low as 0.76 when cowpea was planted four weeks after planting maize. The reduction in the growth and yield of cowpea was due to increased shading from the maize plants especially when cowpea was introduced at the fourth week. Therefore, to achieve yield benefit simultaneous planting of maize and cowpea recommended.

Résumé

Influence du décalage du semis du niébé (*Vigna unguiculata* (L.) Walp.) par rapport au maïs (*Zea mays* L.) sur la croissance et le rendement du niébé

Une recherche a été menée en champs en Ouganda pendant trois saisons consécutives et dans deux sites distincts pour évaluer l'effet du décalage du semis de trois variétés de niébé par rapport à une variété de maïs sur les performances de l'association culturale maïs-niébé en conditions de protection phytosanitaire totale des deux cultures. Les traitements comparés étaient: le semis simultané du niébé et du maïs, en culture pure et en culture associée, le semis du niébé deux semaines après le maïs en culture associée et le semis du niébé quatre semaines après le maïs en culture associée. L'époque de semis du niébé par rapport à celui du maïs a influencé significativement la croissance et la productivité de la légumineuse. Un semis simultané des deux composantes en association s'est traduit par une augmentation de leur productivité par unité de surface par rapport à la culture pure (LER> 1) quelles que soient les variétés du niébé utilisées. Les performances du niébé ont chuté fortement avec le décalage de son semis par rapport à celui du maïs alors que la productivité du maïs s'améliorait légèrement. La productivité la plus faible de l'association culturale (LER= 0,76) a été observée quand le décalage du semis des deux composantes était le plus important (4 semaines). Le semis simultané du niébé et du maïs est donc à recommander si l'on veut optimiser la productivité de cette association culturale.

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp.) is among the most important grain legumes grown in the tropics and sub-tropics. The crop is particularly important in Africa, Nigeria being the largest producer (3). In Uganda, cowpea is ranked third in importance among the grain legumes after Phaseolus beans and groundnut (12). It is most intensively grown in the northern and eastern regions, where the leaves, green pods and dried grains are eaten in various forms. In these regions, cowpea is widely intercropped with a large number of crop species especially maize, sorghum, greengram, cassava, pigeonpea, soybeans and sunflower (1). Reasons for intercropping are varied, depending on individual farmer production goal, but invariably include more crops at harvest, improved yields, increased soil fertility and insurance against total crop failure rather than reductions in pest infestations (5). On the whole, however, average hectarages under

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cowpea per family are usually very small (< 1 ha) and yields are generally low, often < 300 kg/ha, although yields as high as 4000 kg/ha can be achieved with better crop husbandry (13). Although pests are the most important constraint in cowpea production (9, 14) in the tropics, poor agronomic practices definitely contribute significantly to the yield reduction (7). In Uganda, poor weed control, untimely planting and low plant populations further curtail yield (7). There is scanty information about the optimal time to introduce cowpea into the various crops. Evidence from other cropping systems, however, suggest that improved resource utilization and therefore, increased yield can achieved with proper manipulation of time of planting (11). This study investigated the times of planting cowpea in association with maize in order to minimize cowpea and the intercrop yield.

Material and methods

Field experiments were carried out at Makerere University Agricultural Research Institute, Kabanyolo (MUARIK) and at Serere Agricultural and Animal Production Research Institute (SAARI) during the first (February- June) and second (September- December) rainy seasons of 1996 and were repeated at Kabanyolo during the first season of 1997. Kabanyolo (O°28'N, 32°37'E, approximately 1200 m above sea level), receives average annual rainfall of about 1300 mm occurring over two distinct seasons, from February- June (long rains) and September-December (short rains). During the first and second seasons of 1996, mean monthly rainfall averaged 159.3 mm and 138.2 mm, respectively, but only 96.8 mm during the first season of 1997. The soils of the area are deep ferralitic type, naturally rich in potash but low in nitrogen and phosphate. Serere (1°31'N, 33°27'E, 1000 m above sea level) has rainfall which is more or less unimodal, totalling about 1250 mm annually and with temperatures ranges between 22.5° and 27.5° C. Mean monthly rainfall averaged 246.7 and 144.1 mm during the first and second seasons of 1996, respectively.

The experimental sites were reasonably fertile at both locations. The first experiment at Kabanyolo followed a fertilized crop of vegetables, the second was located in a fallow arable land and the third experiment was preceded by well fertilized soybean/sorghum crops. At Serere the experiments were established on land that were left under fallow for the two previous seasons. No additional fertilizer was added during the course of the experiments in order to simulate peasant farmer situations prevalent in the country. Three cowpea varieties were used in the study, two local, i.e., Ebelat and Ecirikukwai, with semi-spreading growth habits and maturity periods of 90 and 80 days, respectively. The third was an introduced variety, IT82D-716 from the International Institute of Tropical Agriculture, Ibadan, Nigeria; it has an erect growth habit with maturity period of 90 days. The maize cv. Longe 1, grows to a height of about 150 cm and has a maturity period of 120 days. Each cowpea variety was grown as sole crop and as an intercrop with maize. Three dates of planting cowpea, relative to maize, were investigated;

T_o in which cowpea and maize were planted simultaneously,

T_1 in which cowpea was planted 2 weeks after planting maize, and

T_3 where cowpea was planted 4 weeks after planting maize.

The sowing dates at Kabanyolo were 15 April 1996, 23 September 1996 and 17 April 1997 and at Serere, 5 April and 1 October 1996 for T_0 cowpea and sole crops. The plots were arranged in a randomized complete block design (RCBD) of split-plot arrangement with three replications. Cowpea varieties formed the main-plots and time of planting cowpea, the sub-plots. Each main-plot measured 18.2 x 5.4 m and contained three sub-plots each 5.4 x 5.4 m.

For all treatments, 4- 6 seeds of cowpea and 3- 4 of maize were planted per hole. After germination (three weeks), the plots were thinned to one plant per planting hole. In order to protect the crops from insects damage and diseases, 400 $g.ha^{-1}$ Dimethoate, 800 $g.ha^{-1}$ Mancozeb and 500 $g.ha^{-1}$ Benomyl were applied at 2- weekly intervals starting three weeks after emergence, until 4 weeks to harvest. Regular hand-hoeing was done as needed in order to maintain the experiment weed-free. Leaf area index (L.A.I.) was determined for both sole and intercrop treatments using the LAI-2000 Plant Canopy Analyzer (LI-COR, Inc. 1990 model, Lincoln, Nebraska 68504, U.S.A.) and this was done at the vegetative, anthesis and pod/ear filling stages. Plant dry weight was determined by taking the above ground portion of 5 plants randomly sampled from each treatment unit. This was also done at three growth stages as for L.A.I. Adhering soil particles and other foreign matters were removed and the plants were oven-dried at 65°C for 48 hours to a constant weight. Mean dry weight per plant was then obtained for each crop species and used for statistical analysis.

Height of maize was measured at plant maturity from a random sample of 10 plants from for each experimental unit. For cowpea, mean number of branches/plant was determined. Seed and yield components were determined for both crops. At maturity, the plants in the middle rows of each experimental unit (6 m^2) were hand-harvested. For cowpea, the number of pods per plant, number of seeds per pod and 100-seed weight were quantified. Ten of the harvested plants from each experimental unit were used to determine the number of pods per plant. The number of seeds per pod was determined by threshing 20 pods selected randomly from the sampled plants. In addition, a random sample of hundred seeds from each experimental unit was weighed to obtain 100-seed weight using a precision advanced electronic balance GT-series (Ohaus Corporation 1994 Model, Florham Park, NJ07932, U.S.A.). The weight of the dried seeds for each experimental unit (6 m^2) was measured, and used to compute seed yield per hectare.

For maize, the yield components measured included the number of kernels rows per cob, number of seeds per kernel row, 1000-seed weight and grain yield per 6 m^2. Yield components were determined after sun drying and weights adjusted to 13% moisture content. The number of kernel rows per cob was determined from a random sample of 10 cobs from each experimental unit, while the number of seeds/row was got from a sample of two rows from each of these cobs per experimental unit. Data collected were subjected to analysis of variance (ANOVA) procedures of Mstatc (Russels D. Freed, Michigan State University, USA). Fisher's Least Significant Difference (LSD) test was used for mean separation at 5% probability level (15). Land Equivalent Ratios (LERs) were computed as described by Mead and Willey (6) to establish the yield advantages of cowpea/maize intercropping system.

Results

Growth parameters

All the growth parameters of cowpea were highly affected by time of introducing cowpea into maize irrespective of the location of study (Tables 1, 2 & 3; Figure 1).

Table 1
Effect of time of introducing cowpea into maize on leaf area index of cowpea

Treatments	Kabanyolo			Serere	
	1st season 1996	2nd season 1996	1st season 1997	1st season 1996	2nd season 1996
V_1 x S	3.27	3.72	1.99	4.49	2.62
V_1 x T_0	1.59	2.53	1.76	2.47	2.07
V_1 x T_1	0.46	2.29	1.13	0.53	1.79
V_1 x T_2	0.15	1.22	0.35	0.22	0.56
Mean	1.37	2.44	1.31	1.93	1.76
V_2 x S	2.96	3.09	1.88	4.07	2.55
V_2 x T_0	1.26	2.74	1.33	2.31	1.89
V_2 x T_1	0.59	1.94	0.94	0.43	1.27
V_2 x T_2	0.10	1.39	0.40	0.20	0.51
Mean	1.21	2.29	1.14	1.75	1.55
V_3 x S	3.14	3.18	2.05	4.32	2.76
V_3 x T_0	2.30	2.60	1.46	2.67	2.17
V_3 x T_1	0.37	2.12	0.96	0.53	1.46
V_3 x T_2	0.15	1.18	0.28	0.28	0.62
Mean	1.49	2.27	1.19	1.95	1.75
LSD_1 5%	0.39	0.48	0.33	0.33	0.05
LSD_2 5%	1.06	1.21	0.36	0.22	0.19
C.V. %	18.45	12.01	15.97	10.19	2.26

Sole crops
V_1 x S= Ebelat; V_2 x S= Ecirikukwai; V_3 x S= IT82D-716

Intercrops
V_1 x T_0 = Ebelat planted simultaneously with maize
V_1 x T_1 = Ebelat planted 2 weeks after planting maize
V_1 x T_2 = Ebelat planted 4 weeks after planting maize
V_2 x T_0 = Ecirikukwai planted simultaneously with maize
V_2 x T_1 = Ecirikukwai planted 2 weeks after planting maize
V_2 x T_2 = Ecirikukwai planted 4 weeks after planting maize
V_3 x T_0 = IT82D-716 planted simultaneously with maize
V_3 x T_1 = IT82D-716 planted 2 weeks after planting maize
V_3 x T_2 = IT82D-716 planted 4 weeks after planting maize
LSD_1 = Time of planting LSD
LSD_2 = Variety LSD

Table 2
Effect of time of introducing cowpea into maize on the number of cowpea branches per plant

Treatments	Kabanyolo			Serere	
	1st season 1996	2nd season 1996	1st season 1997	1st rain 1996	2nd rain 1996
V_1 x S	12.40	20.43	13.93	16.77	18.77
V_1 x T_0	10.47	12.63	9.50	13.47	12.37
V_1 x T_1	5.97	8.20	5.37	10.33	7.33
V_1 x T_2	5.20	6.00	2.67	7.27	4.40
Mean	8.42	11.82	7.87	11.96	10.72
V_2 x S	11.80	19.43	12.40	16.27	16.27
V_2 x T_0	10.47	12.93	9.63	13.53	12.30
V_2 x T_1	5.87	8.73	5.70	10.73	7.73
V_2 x T_2	4.60	5.93	3.00	7.53	4.07
Mean	8.18	11.86	7.68	12.02	10.09
V_3 x S	11.53	19.77	14.33	21.03	19.43
V_3 x T_0	9.13	12.73	8.83	11.73	11.53
V_3 x T_1	7.47	9.60	6.80	11.80	8.20
V_3 x T_2	5.27	6.40	2.73	7.97	3.87
Mean	8.35	12.13	8.18	13.13	10.79
LSD_1 5%	1.77	1.90	1.40	2.40	0.65
LSD_2 5%	4.41	7.06	0.75	3.54	1.04
C.V. %	12.39	9.23	8.38	11.32	3.58

Sole crops
V_1 x S= Ebelat; V_2 x S= Ecirikukwai; V_3 x S= IT82D-716

Intercrops
V_1 x T_0 = Ebelat planted simultaneously with maize
V_1 x T_1 = Ebelat planted 2 weeks after planting maize
V_1 x T_2 = Ebelat planted 4 weeks after planting maize
V_2 x T_0 = Ecirikukwai planted simultaneously with maize
V_2 x T_1 = Ecirikukwai planted 2 weeks after planting maize
V_2 x T_2 = Ecirikukwai planted 4 weeks after planting maize
V_3 x T_0 = IT82D-716 planted simultaneously with maize
V_3 x T_1 = IT82D-716 planted 2 weeks after planting maize
V_3 x T_2 = IT82D-716 planted 4 weeks after planting maize
LSD_1 = Time of planting LSD
LSD_2 = Variety LSD

Cowpea simultaneously planted with maize had on average higher L.A.I., plant dry matter (DM) and more branches per plant than those planted 2 and 4 weeks after planting maize. Overall, the poorest growth of cowpeas was recorded when cowpea was introduced four weeks after planting maize (Tables 1, 2 & 3). Growth of maize plants were not influenced much by time of introducing cowpea into it. However, it is worthwhile to note that maize simultaneously planted with cowpea had generally lower L.A.I., DM, and were shorter compared to those in which the cowpea were introduced two and four weeks later.

Yield and yield components

Cowpea simultaneously planted with maize recorded the least yield reductions compared to sole crops. Delayed planting of cowpea progressively reduced cowpea yield irrespective of the cowpea variety used, although IT82D-716 was on average the most affected (Figure 2).

There was also a significant ($P< 0.05$) reduction in the number of seeds/pod with delayed time of planting cowpea (data not presented). On the contrary, maize grain yield was not affected by time of introducing cowpea (Figure 3).

The Land Equivalent Ratios for simultaneous planted treatments were greater than one, and as time of introducing cowpea into maize was delayed, LER declined progressively. The highest LER was obtained during the first rains of 1996 at Kabanyolo under simultaneous planting (1.42) of IT82D-716 and maize (Table 4).

Due to the drought condition that prevailed during the first season of 1997, the maize crop failed. However, reasonable growth and yield of cowpea was achieved, and the trends generally followed those of 1996 (Tables 1- 4).

Table 3
Effect of time of introducing cowpea into maize on dry matter (DM) and yield (g) of cowpea

Treatments	Kabanyolo			Serere	
	1st season 1996	2nd season 1996	1st season 1997	1st season 1996	2nd season 1996
V_1 x S	53.59	43.51	26.70	64.88	32.63
V_1 x T_0	28.93	38.98	20.83	37.73	28.09
V_1 x T_1	4.69	11.52	6.06	12.41	7.05
V_1 x T_2	2.77	6.16	2.99	4.07	4.90
Mean	22.50	25.04	14.15	29.77	18.16
V_2 x S	48.33	53.35	20.82	68.42	29.32
V_2 x T_0	25.33	25.35	11.27	37.81	14.82
V_2 x T_1	5.92	8.87	7.57	6.90	9.41
V_2 x T_2	1.75	5.16	2.34	3.24	3.01
Mean	20.37	23.18	10.50	29.09	14.14
V_3 x S	58.00	50.78	28.44	65.24	35.38
V_3 x T_0	42.32	32.13	14.12	38.93	21.33
V_3 x T_1	3.70	10.90	6.64	12.90	7.11
V_3 x T_2	2.69	6.60	2.91	6.00	4.98
Mean	26.70	25.10	13.02	30.78	17.20
LSD_1 5%	7.34	12.10	1.18	4.12	1.96
LSD_2 5%	18.57	27.07	1.14	3.65	4.06
C.V. %	16.57	28.73	6.50	8.61	6.94

Sole crops
V_1 x S= Ebelat; V_2 x S= Ecirikukwai; V_3 x S= IT82D-716

Intercrops
V_1 x T_0 = Ebelat planted simultaneously with maize
V_1 x T_1 = Ebelat planted 2 weeks after planting maize
V_1 x T_2 = Ebelat planted 4 weeks after planting maize
V_2 x T_0 = Ecirikukwai planted simultaneously with maize
V_2 x T_1 = Ecirikukwai planted 2 weeks after planting maize
V_2 x T_2 = Ecirikukwai planted 4 weeks after planting maize
V_3 x T_0 = IT82D-716 planted simultaneously with maize
V_3 x T_1 = IT82D-716 planted 2 weeks after planting maize
V_3 x T_2 = IT82D-716 planted 4 weeks after planting maize
LSD_1 = Time of planting LSD
LSD_2 = Variety LSD

Discussion

The lower number of pods per plant recorded in cowpea at later planting dates was probably due to the shading effect of the taller component crop, maize, which obstructed solar radiation from penetrating into the cowpea (lower canopy). Similar findings were reported by Wahua *et al.* (16). Under intercrop situation, Ebelat formed more pods per plant than Ecirikukwai and IT82D-716. IT82D-716 in particular recorded the lowest number of pods per plant when planted four weeks after planting maize. This appeared to be due to its longer maturity period compared to both Ebelat and Ecirikukwai which made the duration of overlap between its growth and maize greater. Baker (2) working on maize/sorghum/millet intercrops reported that greater duration of overlap of two or more crops in association, results into lower yield of the intercrop. The semi-spreading habits of the local cultivars could also be the reason why they produced more pods per plant as compared to the erect IT82D-716. Isenmilla *et al.* (4) reported yield losses of cowpea intercropped with maize in which a spreading type, New Era, sustained less damage (48% yield reduction) than did Ife Brown (62.2%) and Adzuki (67.7%), which are semi-erect and erect plants, respectively. Similarly, Obuo *et al.* (7) obtained better yield advantage when sorghum was intercropped with a semi-spreading cowpea cultivar than an erect cultivar. Delayed planting of cowpea in an already established maize crops generally resulted in a progressive decline in the number of seeds/pod, and consequently, reduced yield. A possible reason for this is that the lower L.A.I. attained when cowpea planting was delayed, could not provide adequate assimilates for grain filling. Under such circumstances, flowers abort and/or seeds are only partially filled. As

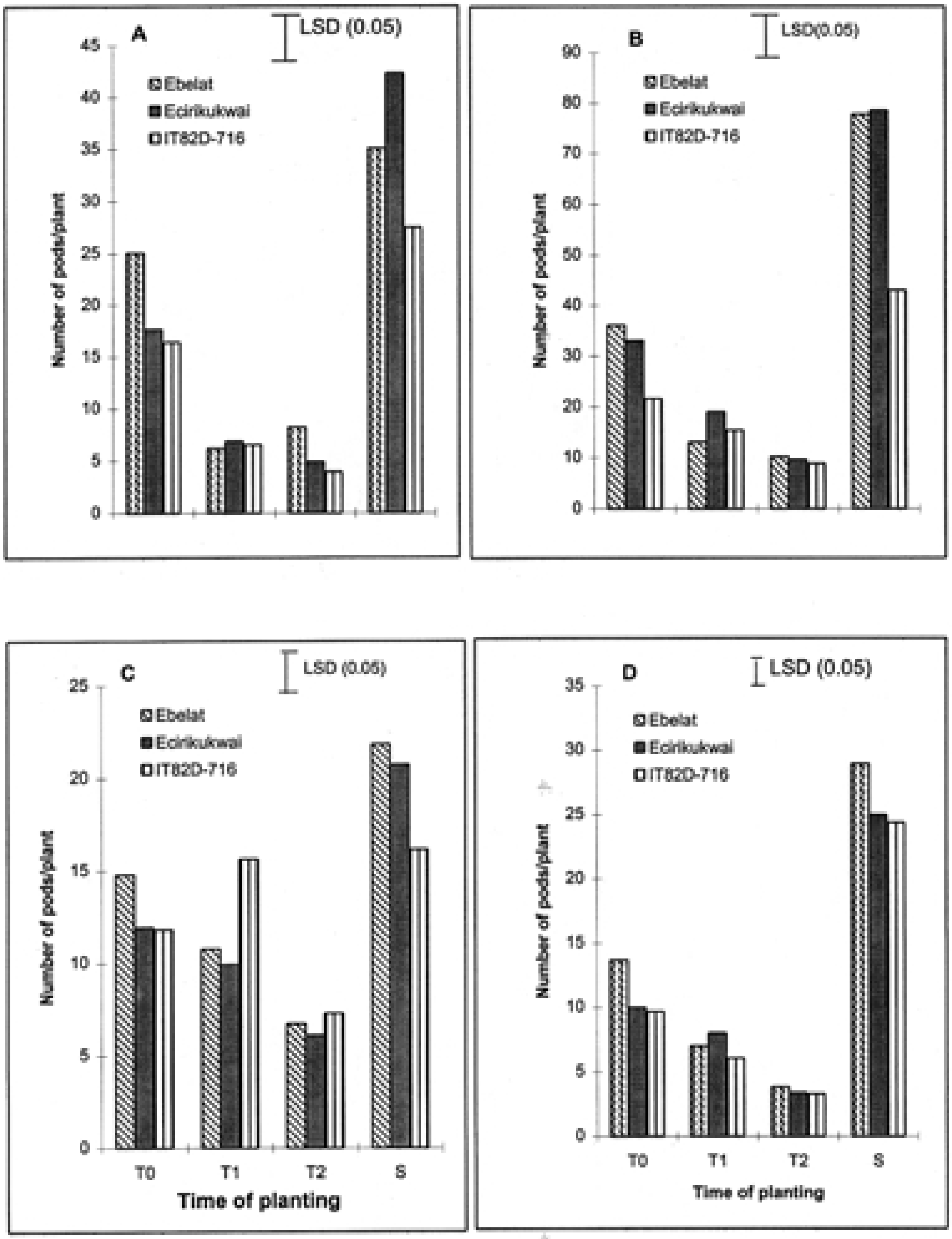

Figure 1: Effect of variety x time of introducing cowpea into maize on number of pods formed during the first (A & C) and second (B & D) rains of 1996 at Kabanyolo (A & B) and Serere (C & D)

expected, sole cowpea had the highest number of pods per plant and seed yield due to the lack of inter-specific competition and shading conditions prevailing under the intercrop situations. Cowpea yields were higher during the second than the first rains of 1996 (Figure 2). This was due to the well distributed rainfall which favoured adequate dry matter production and therefore, many pods per plant were formed. The lower disease incidence (Sphacelona scab) in the second rains (data not presented) also contributed to the higher yield per unit area. The highest yield was obtained from Ebelat sole crop followed by Ecirikukwai, IT82D-716 recorded the least yield. All the intercropped cowpea recorded highest yield when cowpea and maize were planted simultaneously, but yield declined progressively with delay in planting cowpea. These reductions in the grain yields of cow-pea can be explained by the adverse shading effects from the taller component (maize) in the mixture. Maize yields were on the other hand not significantly

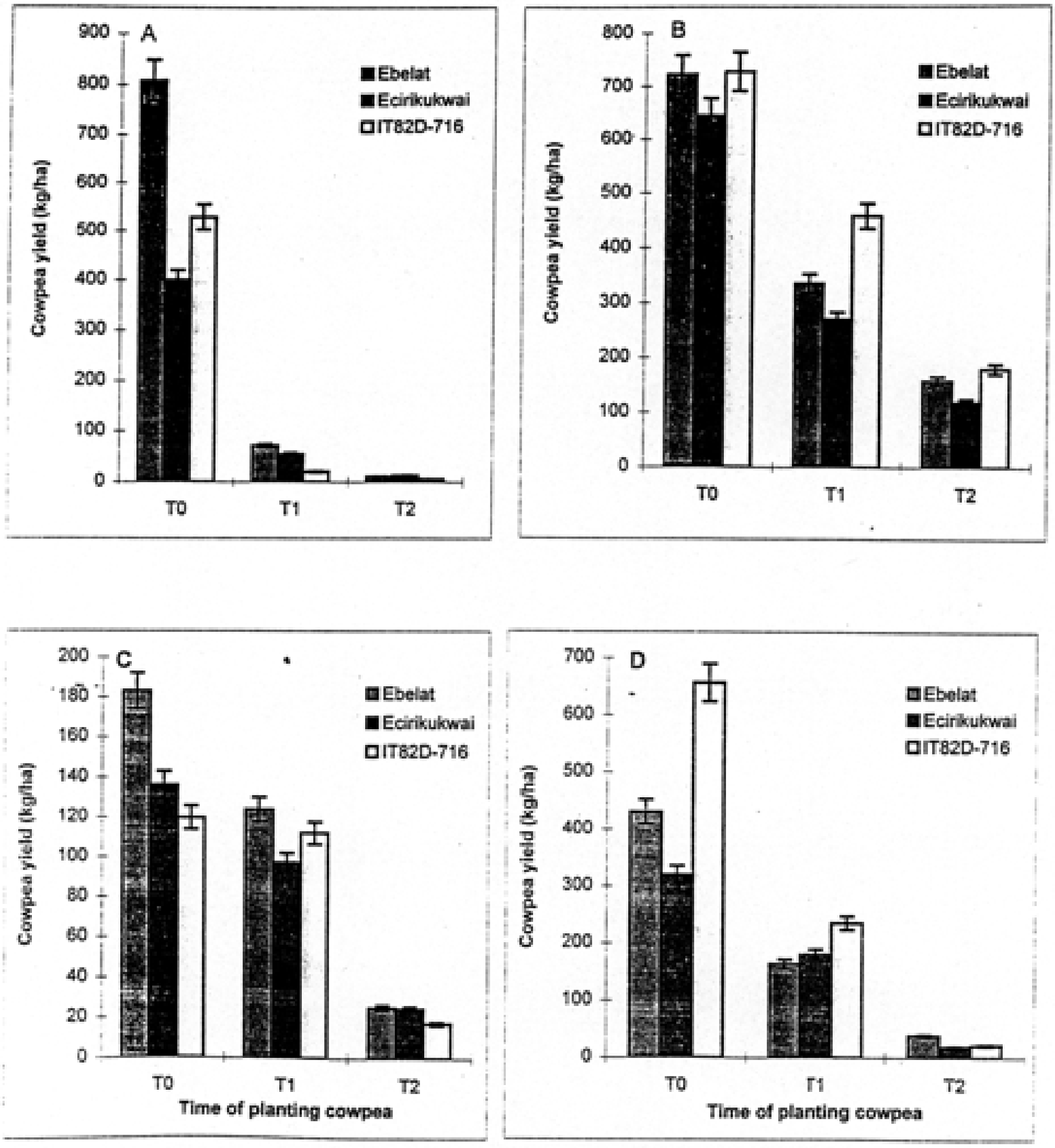

Figure 2: Effect of time of introducing cowpea into maize cowpea yield (kg/ha) during the first (A & C) and second (B & D) rains of 1996 at Kabanyolo (A & B) and Serere (C & D)
T_0 = Simultaneously with maize
T_1 = Cowpea planted 2 weeks after planting maize
T_2 = Cowpea planted 4 weeks after planting maize

affected by the inclusion of cowpea. This is because of the height advantage it had compared to cowpea. Reddey and Visser (11) working on cowpea/millet intercropping reported that the canopies of cereals interfere with light penetration and thus, the yields of intercropped cowpea are reduced. The situation is worsen especially when cowpea planting is delayed relative to millet. Land Equivalent Ratios were generally greater than one where cowpea and maize were planted simultaneously, indicating that yield advantages were achieved in these combinations (17). But when cowpea was introduced two and four weeks later into maize, the LERs were generally less than one largely due to the low cowpea partial LERs. Hence, delayed planting of cowpea adversely affected its growth and yield performance and as such, its contribution to the intercrop system was curtailed. In all cases, the partial LER for maize was higher than for cowpea. This was probably due to the dominant effect of maize in the intercrop as a result of the height

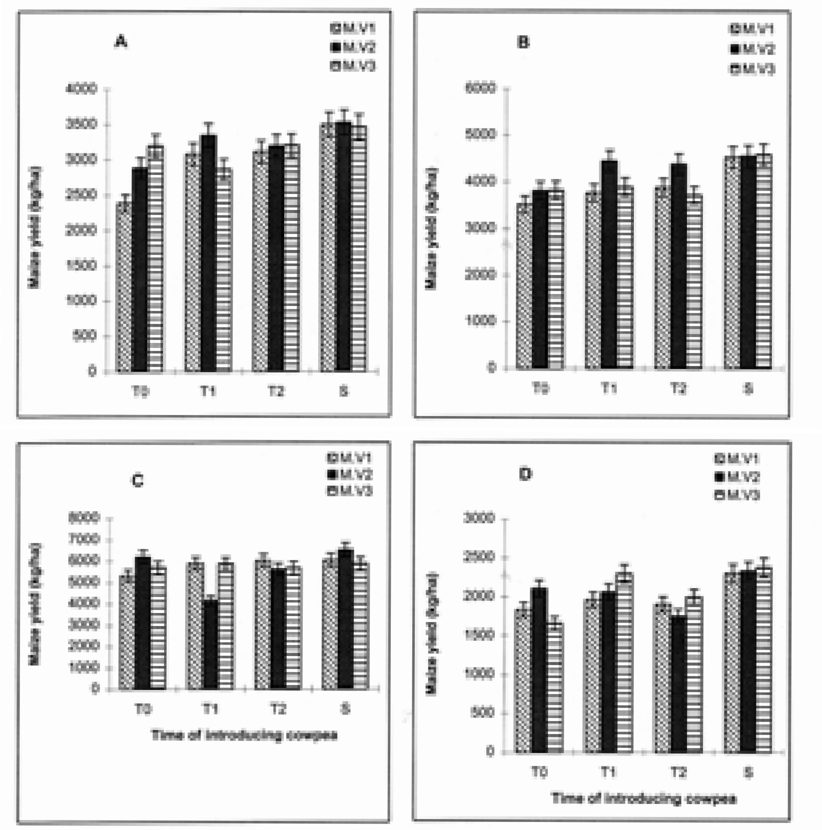

Figure 3: Effect of time of planting cowpea relative to maize on maize grain yield (kg/ha) during the first (A & C) and second (B & D) rains of 1996 at Kabanyolo (A & B) and Serere (C & D)

T_0 = Cowpea and maize planted simultaneously
T_1 = Cowpea planted 2 weeks after planting maize
T_2 = Cowpea planted 4 weeks after planting maize

$M.V_1$ = Maize intercropped with Ebelat
$M.V_2$ = Maize intercropped with Ecirikukwai
$M.V_3$ = Maize intercropped with IT82D-716
S= Sole maize crops

Table 4

Effect of time of introducing cowpea into maize on the Partial and Total Land Equivalent Ratios (LERs) for cowpea and maize

	* First season 1996			Second season 1996		
	Partial LER		Total LER	Partial LER		Total LER
Treatments	Cowpea	Maize		Cowpea	Maize	
Kabanyolo						
$V_1 . T_0$ x M	0.50	0.68	1.18	0.25	0.78	1.03
$V_1 . T_1$ x M	0.04	0.88	0.92	0.11	0.83	0.94
$V_1 . T_2$ x M	0.01	0.80	0.81	0.05	0.86	0.91
$V_2 . T_0$ x M	0.24	0.82	1.06	0.25	0.84	1.09
$V_2 . T_1$ x M	0.03	0.95	0.98	0.11	0.98	1.09
$V_2 . T_2$ x M	0.01	0.91	0.92	0.05	0.96	1.01
$V_3 . T_0$ x M	0.50	0.92	1.42	0.32	0.83	1.15
$V_3 . T_1$ x M	0.02	0.83	0.85	0.21	0.85	1.06
$V_3 . T_2$ x M	0.01	0.93	0.94	0.08	0.81	0.89
Serere						
$V_1 . T_0$ x M	0.46	0.88	1.34	0.24	0.80	1.04
$V_1 . T_1$ x M	0.31	0.98	1.29	0.09	0.85	0.94
$V_1 . T_2$ x M	0.06	0.97	1.03	0.02	0.83	0.85
$V_2 . T_0$ x M	0.35	0.95	1.30	0.22	0.90	1.12
$V_2 . T_1$ x M	0.25	0.64	0.89	0.12	0.85	0.97
$V_2 . T_2$ x M	0.06	0.86	0.92	0.01	0.75	0.76
$V_3 . T_0$ x M	0.26	0.97	1.23	0.52	0.70	1.22
$V_3 . T_1$ x M	0.25	0.99	1.24	0.19	0.97	1.16
$V_3 . T_2$ x M	0.04	0.97	1.01	0.02	0.84	0.88

V_1 = Ebelat; V_2 = Ecirikukwai; V_3 = IT82D-716
*LER for first rains of 1997 at Kabanyolo could not be established because maize crops failed due to insufficient rainfall.

advantage which enabled it to trap much of solar radiation before it could reach the cowpea. Results of our study suggest that higher yield of cowpea in cowpea/maize intercrop can be obtained when the crops are planted at the same time. A progressive yield decline result with delayed introduction of into maize.

Acknowledgements

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