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Relative time of planting of legumes (cowpea, soybean and groundnut) on weed suppression and yield in cassava cropping system

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Weeds are a serious problem farmer's face in tropical Africa, which significantly reduces yield. Field trials were conducted from September 2013 to September 2014 to determine the appropriate relative time of planting of legumes in cassava cropping system for optimum weed suppression. The experimental design was a randomized complete block design (RCBD) with three replicates. Treatments consisted of combinations of three relative times of planting for each of the three legumes (cowpea, soybean, and groundnut). One sole crop each of the legumes and cassava was added for comparison. The results indicated that early introduction of the legume (intercrop) into the cassava showed efficient weed control. The late introduction of the legume (intercrop) into the cassava decreased cassava yield whilst early introduction of the legume into the cassava increased cassava yield. Results from the study also revealed that the relative time of planting did not show any significant difference among the legume grain yield. However, late introduction of the cassava into the intercrop resulted in the highest grain yield.

Key words: Weeds, cassava, legumes, cropping system, relative planting times.

INTRODUCTION

Intercropping is the cultivation of two or more crops at the same time on the same piece of land (Sullivan, 2003). It matches efficiently crop demands to available growth resources and labour. The desire to intercrop is increasing because it increases the productivity of a piece of land (Chapagain and Riseman, 2014). Intercropping provides insurance against crop failure or against unstable market prices for a given commodity, especially in areas subject to extreme weather conditions such as drought and flood. Thus, it offers greater financial stability than sole cropping which makes the system particularly suitable for labour-intensive small farms (Fortin and Pierce, 1996). Besides, intercropping allows lower inputs through reduced fertilizer and pesticide requirements, thus minimizing environmental impacts of agriculture.

Intercropping plays a significant role in integrated weed management and improvement of soil fertility. Weeds are found in our cropping systems and they make up part of the agro-ecosystem in field crop production. Weeds have been given various definitions by different authorities. However, Alex Carson (Pers. Comm., 2002) defined a

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weed in simple terms as “a herbaceous plant growing where it is not wanted and therefore interfering with the utilization of land and water resources or otherwise adversely intruding upon human welfare.” All farmers in their different languages and cultures know weeds and their troubles and hence device ways and means of adequately controlling them to increase crop yield. The maintenance of a complete crop canopy over the soil inhibits weed seed germination and reduces the need for weeding. Early canopy development, inhibits early weed development and reduces weed-crop competition, particularly for soil nutrients and water.

Benefits from intercropping for weed control are particularly evident under low input agriculture and increases in component crop yields have been attributed to improved weed control (Taah et al., 2017). Bilalis et al. (2010) and Gronle et al. (2015) also reported that intercropping increased light interception by the weakly competitive component and can, therefore, shorten the critical period for weed control and reduce growth and fecundity of late-emerging weeds. The apparent increased competitiveness of intercropping systems make them potentially useful for adoption into low in-put farming systems in which options for chemical weed control are reduced or non-existent (Saudy and El-Bagoury, 2014; Szumigalski and Van Acker, 2005; Zimdahl, 2007).

A serious disadvantage in intercropping is thought to be the difficulty with practical management, especially where there is a high degree of mechanization or when the component crops have different requirements for fertilizers, herbicides and pesticides. Mechanization is a major problem in intercropping because machinery used for sowing, weeding, fertilizing and harvesting are made for big uniform fields. Harvesting remains a great problem, but it may be more easily overcome where the intercrops are harvested for forage or grazed. In developing countries, the work needed in the field is mainly done by hand with simple tools because intercropping is very labour intensive.

In cassava legume intercrop, several factors influence the productivity and efficiency of the system. However, the major factors include: relative time of planting component crops; plant density or population; spatial arrangement of component crops and effect of applied nitrogen.

Relative time of planting, that is, planting the intercrop before, at the same time or after the main crop has both biological and practical implications on the component crops. Different planting times for component crops improve productivity and minimize competition for growth limiting factors in an intercrop. The biological implications of time of planting component crops include the fact that the main crop does not impose much competitive ability at the beginning of its growth cycle and it does not tolerate much competition either. On the other hand, if the main crop is planted earlier than the intercrop, shading and competition for other growth factors may affect weed suppression, growth and yield of the latter.

However, relative time of planting of the legumes in association with cassava in Ghana has not been extensively studied and not well documented. This research, therefore, seeks to evaluate the effects of relative time of planting of legumes (cowpea, groundnut, and soybean) on weed suppression in cassava-based cropping system.

MATERIALS AND METHODS

Location and study area

The experiment was carried out at the Asuansi Farm Institute in the Abura-Asebu-Kwamankese district, in the Central Region of Ghana. The area lies in the southern fringes of the semi deciduous rainforest with two wet seasons in a year. The rainfall pattern follows the traditional double maxima (bimodal) distribution experienced in most parts of southern Ghana with a mean annual rainfall of about 980 mm. The major season rain starts in March and ends in July whilst the minor season rain commences from September to mid-November. Temperatures are generally warm and uniform throughout the year with a mean monthly temperature of about 26.9°C. The soil type is Acrisols (FAO-UNESCO classification) and belongs to the Asuansi series of the Asuansi-Kumasi/Nta-Ofin compound association.

Planting materials

Cassava (*Manihot esculenta* Crantz), early maturing and high yielding cassava variety, ‘Capevars bankye’ was used.

Early maturing cowpea (*Vigna unguiculata* L.), ‘Asetenapa’ with erect growth habit couple with high yielding potential.

High yielding groundnut (*Arachis hypogea* L.) variety, ‘Yenyawoso’ was used. The groundnut variety ‘Yenyawoso’ literally means “None like you,” is high yielding and matures within 90 to 95 days. It has a semi-erect growth habit and a yield potential of 2.7 t ha^{-1}. It was developed at CSIR-CRI, Fumesua, Kumasi.

The soybean (*Glycine max*) variety ‘Anidaso’ is resistant to shattering, nodulates freely with the indigenous cowpea/groundnut rhizobia in Ghanaian soils. It matures in 105 to 115 days, with a plant height of 35 to 40 cm and yields 1.2 to 1.8 t ha^{-1} (CRI, 1996).

Experimental procedure

Land preparation

The land preparation was done manually with machetes, axe and rakes. The site after clearing was left to dry. The sticks and woody parts of the debris were removed from the site but the leaves were left as mulch. The field was thereafter marked out into blocks and plots for planting.

Experimental design

The experiment was carried out in a Randomized Complete Block Design (RCBD) with 13 treatments and 3 replications. This gave a total of 39 plots. Each plot measured 5 m × 4 m with a space of 0.5 m between each plot and 1.0 m between blocks. There was a 1.0 m guard area around the experimental area; this gave a total of 1160 m^2 or 0.116 ha. The treatments included sole crops of the individual crops and their combinations are shown in Table 1.

Table 1. Treatment combinations in relation to relative time of planting.

Treatment code	Descriptions
C_SC_o	Cassava planted same day as cowpea
$C_{14}C_o$	Cassava planted 14 days after cowpea
$C_{28}C_o$	Cassava planted 28 days after cowpea
C_SG	Cassava planted same day as groundnut
$C_{14}G$	Cassava planted 14 days after groundnut
$C_{28}G$	Cassava planted 28 days after groundnut
C_SS	Cassava planted same day as soybean
$C_{14}S$	Cassava planted 14 days after soybean
$C_{28}S$	Cassava planted 28 days after soybean
C_0	Sole cowpea
G	Sole groundnut
S	Sole soybean
C	Sole cassava

C - cassava, C_0 - cowpea, G - groundnut, S - soybean.

Agronomic practices

Since the study involved weed management, no fertilizer or herbicide/weedicide was applied. An insecticide Lamdacyhalothrin 2.5% EC was applied 5 weeks after planting to control grasshoppers (*Zonocerus variegatus*) on the experimental plots (their presence was probably due to the leaves left as mulch).

Weed identification, weeding and weed weight measurement

A quadrat with dimension of 50 cm^2 was used for sampling weeds diagonally on the experimental plots. The individual weeds in the quadrat were counted and identified by botanic characterization of the weeds using a handbook of West African weeds (Akobundu and Agyakwa, 1987).

Weeding was done twice with a hoe at 4 and 8 weeks after planting (WAP) for all the experimental plots. After each weeding, the soil adhering to the weeds were carefully removed and the weed material weighed with an electronic balance (Sartorious Mechatronics, Boutersem, Belgium). In each case, the fresh weed weight was recorded and the weeds were dried at 60°C in a GenLab Oven (GenLab Limited, Cheshire, UK) for 72 h, allowed to cool and weighed with an electronic balance to obtain the dry weight.

Harvesting

At harvest, one middle row was harvested for sole and intercropped cowpea, soybean, groundnut and cassava plots.

Cowpea

The cowpea pod matures and dries at different intervals; therefore, harvesting of the dried pods was spread over a period of two weeks from 67 to 80 days after planting (DAP). The pods were further sun-dried and threshed. The seeds were weighed with an electronic balance.

Groundnut

Groundnut was harvested between 90 and 95 days after planting (DAP). Plants from each harvestable plot were carefully uprooted at physiological maturity when most of the leaves had turned brown. The harvested pods were counted, sun dried and shelled to obtain the seeds which were weighed with an electronic balance.

Soybean

Soybean was harvested at 90 days after planting (DAP) when 95% of the pods had turned brown according to Johnson and Major (1978) by up-rooting the whole dry plants. Harvested soybean pods were sun-dried and threshed and weighed with an electronic balance.

Cassava

The cassava stands were harvested 40 weeks after planting (WAP), gathered and the roots were weighed per plot and recorded.

Parameters measured on legumes

Number of seeds per pod and 100-seed weight (g)

Ten pods were shelled individually and the seeds counted. The average number of seeds per pod was then determined. Then, 100 seeds were randomly selected from the seeds of each plot and weighed to give 100-seed weight.

Grain yield (t ha^{-1})

Grain yield was determined by shelling and weighing grains per plot and then expressed in tonnes per hectare (t ha^{-1}). Moisture content of the samples was taken using a seed moisture meter (Seedburo Equipment Company, Illinois, USA).

Cassava parameters measured

Root length (cm)

Root length was measured from the base of the root to the tip. The

Table 2. Predominant weeds identified with their family name, growth form and degree of occurrence.

Weed species	Degree of occurrence	Growth form	Family
Boerhavia diffusa	+	AF	Nyctaginaceae
Centrosema pubescens Benth.	+++	AF	Fabaceae
Chromolaena odorata L.	+++	PF	Asteraceae
Commelina diffusa L.	++	AF	Commelinaceae
Euphorbia heterophylla L.	+	AF	Euphorbiaceae
Portulaca maximum Jacq.	++	AF	Portulacaceae
Tridax procumbens L.	++	AF	Asteraceae
Talinum triangulare	+++	AF	Portulacaceae
Digitaria longiflora (Retz.) Pers	+	AG	Poaceae
Imperata cylindrical	+	PG	Poaceae
Panicum maximum	+++	PG	Poaceae
Pennisetum pedicellatum Trin	+	AG	Poaceae
Cyperus rotundus	+	PS	Cyperaceae
Amaranthus spinosus	+	AF	Amaranthaceae

+ Low, ++ Medium, +++ High. AF: Annual forb/broad weed; AG: annual grass; PF: perennial forb/broad weed; PG: perennial grass; PS: perennial sedge.

measurement was made on five marketable roots from the harvestable plot and the average taken as the mean root length.

Fresh root yield (t ha^{-1})

Root yield was determined by weighing the roots. Roots from five plants were bulked and placed in a sack. The sack was placed on a hanging scale and the weight recorded. The weight was divided by five to obtain the fresh root weight per plant. Based on the mean root weight per stand and at a spacing of 1.0 m × 1.0 m the yield per hectare was estimated for all the treatments.

Data analysis

Data were subjected to analysis of variance (ANOVA), using the GenStat Version 8.1 program (GenStat, 2012). The differences between the treatment means were separated using the least significant difference (LSD). The significant differences between the treatments were compared with the critical difference at a 5% probability level.

RESULTS AND DISCUSSION

Weeds identification

From a survey on the experimental field, a total of 14 weed species from 10 families were recorded (Table 2) with the Poaceae, Fabaceae and Asteraceae families being the dominant ones. The weed species that were dominant (High) on the field were *Centrosema pubescens* Benth*, Chromolaena odorata* (L), *Talinum triangulare* and *Panicum maximum* whilst the least (Low) weed species recorded were *Boerhavia diffusa, Euphorbia heterophylla* L.*, Digitaria longiflora (Retz.)* Pers*, Imperata cylindrica, Pennisetum pedicellatum* Trin*, Cyperus rotundus* and *Amaranthus spinosus* (Table 2).

The weed species observed on the field were grouped based on their growth form into broad weeds (annual and perennial), grasses (annual and perennial) and sedges (perennial). More of the annual forbs and perennial grasses were recorded. The annual broad weeds were *Boerhavia diffusa, C. pubescens* Benth.*, Commelina diffusa* L., *E. heterophylla* L.*, Portulaca maximum* Jacq and *Tridax procumbens* whilst the perennial grasses included *Imperata cylindrica* and *Panicum maximum. Chromolaena odorata* L. was the only perennial broad weed recorded.

Effect of time of planting on weed dry weight

The effect of time of planting on weed dry weight in the 4 and 8th weeks after planting is presented in Table 3. Statistical analysis showed highly significant difference ($p<0.05$) for weed dry weight for the 4 and 8th week after planting in the cassava-legume based cropping in relation to time of introducing the main crop into the component crops (Table 3).

Relative time of planting reduced weed dry weight in the 4th week after planting with a further reduction of weeds in the 8th week after planting (Table 3). The lowest weed dry weight was recorded for the planting of the main crop and the component on the same day. The result shows that cassava planted same day with groundnut recorded reduced weed dry weight of 0.34 and 0.17 t ha^{-1} for the 4 and 8th WAP, respectively. This was followed by cassava planted same day with cowpea and soybean (Table 3). The reduction in the weed dry weight

Table 3. Effect of time of planting on weed dry weight (t ha^{-1}).

Time of planting	4 WAP	8 WAP
Sole cassava	1.00	0.54
Cassava planted same day with cowpea	0.40	0.15
Cassava planted 14 days after cowpea	0.44	0.20
Cassava planted 28 days after cowpea	0.48	0.24
Cassava planted same day with groundnut	0.34	0.17
Cassava planted 14 days after groundnut	0.52	0.20
Cassava planted 28 days after groundnut	0.54	0.27
Cassava planted same day with soya bean	0.44	0.19
Cassava planted 14 days after soya bean	0.55	0.22
Cassava planted 28 days after soya bean	0.61	0.25
CV (%)	8.80	16.9
Lsd (0.05)	0.07	0.06

might have been due to large surface area covered by the legumes and cassava which suppressed the growth and development of weeds and hence controlling the weeds.

Leihner (1984) postulated that cassava intercropped with legume, ensured better coverage of soil surface which diminished light penetration, thus reduced weed growth such that there was no need for other weed control measures. Zuofa et al. (1992) also suggested the use of groundnut or cowpea or melon as smother crop in cassava intercropping system wherein the best weed control was achieved.

The late introduction of the main crop into the component crop also reduced weed dry weight (Table 3). Cassava planted 28 days after cowpea; groundnut and soybean reduced dry weed weight for the 4 and 8th WAP. Average reduction in weed weight (0.44, 0.52 and 0.55 t ha^{-1}) was recorded for cassava planted 14 days after cowpea, groundnut and soybean, respectively in the 4th week after planting. Also, further reduction of weed dry weight (0.20 t ha^{-1}) was recorded for cassava planted 14 days after cowpea and groundnut and weed dry weight (0.22 t ha^{-1}) cassava planted 14 days after soybean in the 8th week after planting (Table 3).

The result indicates that introduction of main crop with the component crop on the same day controlled weeds efficiently than late introduction of the main crop into the cropping system. This might be as result of high plant density in the cropping of the main crop and component crop on the same day leading to large area coverage, hence, smothering of weeds leading to efficient weed control.

Effect of time of planting on legume seed yield

The legume yield was highly significantly ($p<0.05$) affected by time of planting with relation to cassava-legume cropping systems. The time of introducing the main crop into the component crop highly significantly ($p<0.05$) affected the 100 seed weight in the cassava-legume cropping system. The yield of the legumes and the 100 seed weight was significantly lowered by the time of planting (Table 4).

The time of planting significantly ($p<0.05$) lowered cowpea seed yield (Table 4). Cowpea yield for cassava planted 28 days after cowpea out yielded cowpea yield for cassava planted same day as cowpea (Table 4). Analysis of variance showed that cassava planted 28 days after cowpea gave significantly higher seed yield of 2.55 t ha^{-1} than those of both intercrops being planted the same day and 14 days after cowpea with yield of 1.88 and 2.10 t ha^{-1}, respectively (Table 4).

The reduction in seed yield of cowpea introduced same day in cassava-cowpea intercrop has also been documented (Abdul-Rahaman, 2006). The reduction in the yield of the cowpea component in the present study and those of other workers has been attributed to inter specific competition for resources (Adaji et al., 2007; Cenpukdee and Fukai, 1992).

The time of introducing the cassava into the cropping system was highly significant ($p<0.05$) and influenced the seed yields of groundnut in the cassava-groundnut intercrop (Table 4). Maximum seed yields (1.02 and 0.85 t ha^{-1}) were recorded in the treatment of cassava planted 28 days after groundnuts and cassava planted 14 days after groundnuts, respectively (Table 4). The minimum seed yield (0.84 t ha^{-1}) was recorded for the treatments of cassava planted same day as groundnuts. The time of planting the cassava decreased groundnut seed yield in the cassava-groundnut intercrop may be as a result of competition for water, and nutrients between the main crop (cassava) and the component crop (groundnut) when planted on the same day. Caballero et al. (1995) have reported the decreased seed yields as a result of time of planting the crop. This was attributed to the interspecific competition between the two crops for resources (Assefa and Ledin, 2001) and competition gap

Table 4. Effect of time of planting on legume grain yield (t ha^{-1}).

Time of planting	100-seed weight (g)	Yield (t ha^{-1})
Cowpea	16.87	2.77
Cassava planted same day as cowpea	15.13	1.88
Cassava planted 14 days after cowpea	15.40	2.10
Cassava planted 28 days after cowpea	15.67	2.55
Groundnut	51.57	1.24
Cassava planted same day as groundnut	47.70	0.84
Cassava planted 14 days after groundnut	48.53	0.85
Cassava planted 28 days after groundnut	50.37	1.02
Soybean	9.89	1.62
Cassava planted same day as soya bean	8.97	0.68
Cassava planted 14 days after soya bean	9.40	0.90
Cassava planted 28 days after soya bean	9.57	1.53
CV (%)	8.40	9.70
Lsd (0.05)	3.40	0.24

between the periods when each of the component crops was making critical demands for growth resources such as light, water and nutrients (Trenbath, 1993).

In cassava-soybean based cropping systems, 100-seed weight and seed yield of soybean were significantly ($p<0.05$) lowered by time of sowing soybean (Table 4). The highest yield (1.02 t ha^{-1}) was recorded for soybean in an intercrop of cassava planted 28 days after soybean and the lowest soybean yield (0.63 t ha^{-1}) for cassava planted same day with soybean (Table 4). Planting cassava 28 days after cassava resulted in increased seed yield because the crop component was subjected to less competition for growth resources and had enough time for seed filling, hence, higher yield. The results obtained corroborated the works of Adeniyan and Ayoola (2006) on cassava-soybean intercrop, in which they were of the view that the performance, quality and quantity of obtainable seed yield of soybean could be seriously affected by both micro-climatic environment of the crop species and macro-climatic conditions from the time of planting to the time of harvesting of the component crops in the mixture. Also, Udealor (2002) in cassava-cowpea intercropping system noted that the earlier the legume was planted in the intercropping system the lesser the shading effect resulting in higher yield of the legume crop.

Effect of relative time of planting on cassava yield (t ha^{-1}), number of roots per plant and root length (cm)

In all, the cassava-legume based cropping systems, cassava root yield were highly significantly ($p<0.05$) and were affected by the cropping systems. Time of planting did not significantly ($p>0.05$) affect mean root length. However, mean number of root and root yield was significantly ($p<0.05$) lower than the sole cassava (Table 5).

The time of planting significantly ($p<0.05$) lowered the cassava root yield (Table 5) in the intercrop. The earlier cassava was introduced into the cowpea intercrop, the higher its root yield. Cassava planted same day with cowpea recorded the highest root yield (28.20 t ha^{-1}) while cassava planted 14 days after cowpea recorded root yield (26.55 t ha^{-1}). The lowest root yield (25.75 t ha^{-1}) was recorded for late introduction of the cassava into the cowpea, which is cassava planted 28 days after cowpea. Similarly, Ayoola and Makinda (2008) observed that cassava planted the same day as cowpea gave significantly higher yields than cassava planted 28 days after cowpea.

Cassava planted 28 days after the groundnut significantly decreased cassava storage root yields (25 t ha^{-1}) as compared to cassava planted at the same time as groundnut (29.05 t ha^{-1}) in the cassava-groundnut intercrop, probably due to the interspecific competition for growth resources (space, moisture and nutrients) between the two crops, Hillocks et al. (2002) and shading by groundnut plants when cassava was planted 3 weeks after the groundnuts. Cassava yields could be considerably decreased if the intercrop was planted earlier than cassava, creating strong interspecific competition for growth resources at a time when cassava was still a weak competitor (Leihner, 2002). The highest cassava root yield (29.05 and 26.71 t ha^{-1}) was recorded for cassava planted same day as groundnut and 14 days after groundnut (Table 5). The results is confirmed by Mason et al. (1986) who indicated that cassava can be planted at the same time or not later than 2 weeks (14 days) after the groundnut without affecting the root yield in the cassava-groundnut intercrop.

The results of this study suggest that the presence of

Table 5. Effect of relative time of planting on cassava yield, number of roots per plant and root length.

Time of planting	Number of roots	Root length (cm)	Fresh root yield (t ha^{-1})
Cassava	9.33	29.33	39.00
Cassava planted same day as cowpea	8.67	27.67	28.20
Cassava planted 14 days after cowpea	7.00	26.00	26.55
Cassava planted 28 days after cowpea	6.40	25.33	25.75
Cassava planted same day as groundnut	8.67	28.33	29.05
Cassava planted 14 days after groundnut	7.00	27.67	26.71
Cassava planted 28 days after groundnut	6.55	25.00	25.00
Cassava planted same day as soybean	8.60	28.33	30.00
Cassava planted 14 days after soybean	7.33	27.00	28.50
Cassava planted 28 days after soybean	7.00	26.00	27.13
CV (%)	5.80	8.70	6.50
Lsd (0.05)	0.76	4.06	3.16

groundnut in the cassava-groundnut intercrop had no negative effect on the root yields of cassava when cassava was planted at the same time or not later than 14 days after the groundnuts (Table 5).

The fresh root yield and mean number of roots were highly significantly ($p<0.05$) affected by cropping system irrespective of the time of planting soybean (Table 5). However, there was no significantly ($p>0.05$) effect of time of planting on the mean root length. The sole cropped cassava gave higher mean number of roots (9.33) and fresh tuber yield (39.00 t ha^{-1}).

The highest fresh root yield in cassava (30.00 t ha^{-1}) was obtained when soybean was planted same day as cassava and cassava planted 14 days after soybean with yield value of 28.50 t ha^{-1} an indication that planted cassava earlier had greater competitive advantage for growth resources than the others in the intercropping system. The findings corroborated the observations of Ofori and Stern (1987) who surmised that earlier sown component crops in intercropping often have an initial competitive advantage over the ones planted later. The yield of cassava was reduced to 27.13 t ha^{-1} when cassava was planted 28 days after soybean, which indicated a progressive decline with delayed planting of cassava in the intercropping system (Table 5). Similarly, Mbah et al. (2008) reported progressive decline with delayed planting of cassava in the intercropping situation. The findings also corroborated the results obtained by Tijani and Akinnifesi (1996) in cassava/soybean mixture.

Effect of time of planting on land equivalent ratio (LER)

The land equivalent ratio recorded for the cassava-legume based cropping systems in relation to time of planting was greater than one (1.0) for all the different cropping patterns (Table 6). There was highly significant ($p<0.05$) effect of time of planting on LER.

LER was significantly influenced by time of introduction of soybean (Table 6). Cassava planted 28 days after soybean gave the highest LER of 1.63, followed by cassava planted 28 days after cowpea with LER of 1.60 and cassava planted 28 days after groundnut with LER of 1.46. The lowest LER was recorded by treatments in which cassava was planted the same day as soybean (1.20) while cassava planted the same day as groundnut gave a low LER (1.28) with cassava planted same day cowpea recording LER of 1.37.

According to Edje (1987), if the LER is equal to 1.0, then there is no difference in yield between growing the crop in pure or mixed stands. If the LER is greater than 1.0, there is a yield advantage when both crops were grown as mixed compared to pure stands, if, however, the LER is less than 1.0, it will be better in terms of yield to grow both crops separately, as it indicates yield disadvantage. In the present study, the LER was greater than 1.0 in all the treatments, indicating that it is advantageous to grow cassava and legumes (cowpea, groundnut and soybean) in association than in pure stands. There is evidence from the results that cassava planted 28 days after the legumes (cowpea, groundnut and soybean) recorded the highest LER is the best arrangement for cassava-legumes (Table 6) (cowpea, groundnut and soybean) intercropping.

Several workers have also obtained LER greater than 1.0 in cassava-legume intercropping. Mason et al. (1986) observed LER of 1.48 to 1.56 for cassava-cowpea intercrop. Mba and Ezumah (1985) had also reported of higher production efficiency in cassava-cowpea, cassava-groundnut and cassava-soybean intercropping systems. The higher productivity of the intercrop system compared to the sole crop may have resulted from complementary and efficient use of growth resources by the component

Table 6. Effect of time of planting on land equivalent ratio (LER) of cassava/legume intercropping system.

Time of planting	Land equivalent ratio (LER)
Cassava planted same day as cowpea	1.37
Cassava planted 14 days after cowpea	1.43
Cassava planted 28 days after cowpea	1.60
Cassava planted same day as groundnut	1.28
Cassava planted 14 days after groundnut	1.42
Cassava planted 28 days after groundnut	1.46
Cassava planted same day as soybean	1.20
Cassava planted 14 days after soybean	1.40
Cassava planted 28 days after soybean	1.65
CV (%)	8.40
Lsd (0.05)	0.21

crops (Li et al., 2006).

Conclusion

The dry weight of weeds was significantly high with sole cassava than any other treatment. However, intercropping cassava with legumes (cowpea, groundnut and soybean) significantly suppressed weeds. It was evident that early introduction of the legumes with component crop showed efficient weed control for the relative time of planting.

The relative time of planting did not show any significant difference among the legume grain yield. However, late introduction of the cassava into the intercrop resulted in the highest yield. The highest yield of 2.55, 1.02 and 1.53 t ha^{-1} was recorded for cassava planted 28 days after cowpea, groundnut and soybean, respectively.

In contrast, late introduction of the main crop into the component crop decreased cassava yield whilst early introduction of the main crop into intercrop increased cassava yield. High cassava yields of 30.50, 29.05 and 28.20 t ha^{-1} were recorded for treatments of cassava planted same day as soybean, groundnut and cowpea, respectively. The result, therefore, indicates that a farmer who wants the highest possible legume (cowpea, groundnut and soybean) yield in addition to cassava should plant cassava 28 days after the legume and if the objective is to obtain the highest possible cassava yield in addition to legumes (cowpea, groundnut and soybean), then, the obvious choice is planting the cassava the same day as the legume (cowpea, groundnut and soybean).

Recommendation

It is recommended that studies should be carried out on time for the introduction of the main crop into the intercrop for which the cassava should be planted 14 or 28 days before the planting of the legumes in order to evaluate the effect of delaying the intercrop in cassava-legume intercropping on legume grain yield, cassava yield and their ability to suppress weeds.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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