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Evaluation of Crop Yield of African Yam Bean, Maize and Kenaf Under Intercropping Systems

O.N. Adeniyan, S.R. Akande, M.O. Balogun and J.O. Saka

Institute of Agricultural Research and Training,
Obafemi Awolowo University, P.M.B. 5029 Moor Plantation, Ibadan, Nigeria

Abstract: The effect of cropping systems on crop growth and yield of kenaf, maize and African yam bean (AYB) intercropped was investigated for two years (2003 and 2004) at the research farm of the Institute of Agricultural Research and Training (IAR and T) Ibadan. Significantly taller maize and kenaf plants were observed under maize/kenaf/AYB intercrop compared to other cropping systems. Highest seed yield of AYB was obtained in maize/kenaf/AYB and AYB/kenaf intercropping systems while the lowest seed yield was recorded from sole AYB. On the other hand, the highest grain yields of maize and kenaf were obtained when planted sole and in intercropped with AYB. The maize/kenaf/AYB intercropping system gave the highest value of land equivalent ratio (1.12) indicating that planting the three crops together gives higher productivity compared to sole cropping.

Key words: Yield · maize · kenaf · African yam bean · intercropping

INTRODUCTION

Intercropping is an age-old practice of cultivation used by the farmers of tropical and sub-tropical countries. Intercropping is believed to reduce risk and maximize farm revenue, in addition to the relatively high soil and labuor productivity [1]. Maize (*Zea may* L.) has been recognized as a common component in most intercropping systems. It was reported that about 75 percent of the area of maize in Nigeria is in association with other crops [2]. However, in Nigeria, the planting of African yam bean (*Sphenostylis stenocarpa Hoechst*) is usually in association with yam (*Dioscorea* sp.) in which the same stake serves as support for both crops [3]. It is also planted in association with maize and other crops [4]. Staking is as important in African yam bean grown as a sole crop as when grown in intercropped with other crops. Therefore, efforts have to be made to provide stakes for a better growth and yield.

Kenaf (*Hibiscus cannabinus* L.) is gradually gaining relevance in the intercropping system in some parts of the country because of its economic potential and role in the cottage fiber industry [1]. Intercropping fiber crop with legumes and cereals has been shown to give higher returns than sole cropping [5]. It has also been suggested that intercropping single rows of groundnut, soybean or black gram between paired or triple roselle rows spaced 15 cm apart would be commercially more viable than a sole roselle crop, particularly if the intercrops are sown 15 days after the roselle [6].

As a result of additional cost in providing staking materials in African yam bean cultivation as well as its growth that is very slow without staking, there is a need to device a means of intercropping the crop with other crops. However, little or no information exists on kenaf growing in association with cereal and or legume crops in rain forest agro ecology. The objective of this study, therefore, was to evaluate the effect of intercropping on crop growth and yield in Kenaf/Maize/African yam bean intercropping system under rainforest ecology.

MATERIALS AND METHODS

The study was conducted during the cropping seasons of 2003 and 2004 at the Research Farm of the Institute of Agricultural Research and Training, Moor Plantation, Ibadan (lat. 7° 22'N, long. 3° 50'E). This is in the lowland rainforest agro ecological zone of Southwest Nigeria. The average annual rainfall varies from 1000 to 1350 mm and has a bimodal distribution. The dominant soil of the experimental site is sandy loam of an alfisol. The experimental design was a Completely Randomized Block Design (CRBD) with three replications of 4×5 m

Corresponding Author: Dr. O.N. Adeniyan, Institute of Agricultural Research and Training, Obafemi Awolowo University, P.M.B. 5029 Moor Plantation, Ibadan, Nigeria

plot size. There were seven treatments; these are African yam bean (AYB)/Maize/Kenaf, AYB/Kenaf, AYB/Maize, Maize/Kenaf, sole maize, sole kenaf and sole AYB. Kenaf and maize were planted at the same time, while AYB was sown four weeks after. About four seeds of Cuba 108 (kenaf variety) and two seeds of DMR-ESR-Yellow maize variety were sown per hole in their respective rows and later thinned to two and one plant(s) per stand of the respective crop. The inter and intra row spacing for kenaf was 1×0.5 m (40,000 plants ha^{-1}), while maize was 1×1 m (10,000 plants ha^{-1}). The sole kenaf and maize seeds were sown at 0.5×0.2 m (100,000 plants ha^{-1}) and 0.75×0.25 m (53,320 plants ha^{-1}), respectively. Seeds of African yam bean were sown in row between rows of kenaf and maize plants at 0.5 m inter-rows and 0.8 m intra-row spacing (25,000 plants ha^{-1}). At emergence, the seedlings were thinned to one plant per stand. The plants were staked using bamboo poles where necessary with two plants per stake. Pest incidence was low and no insecticide was applied.

A basal application of 120 kg ha^{-1}. NPK (15-15-15) compound fertilizer was applied to maize and kenaf plants. At anthesis, a second dose of fertilizer was applied to maize in form of 40 kg N ha^{-1} using urea. Agronomic parameters taken were plant height at 12 weeks after sowing (WAS) and seed yield for kenaf. Plant height at 12 weeks after sowing (WAS) and grain yield were recorded for maize. While only seed yield was recorded for African yam bean. Data were analyzed using Genstat statistical package and Land Equivalent Ratio (LER) was estimated to test the productivity of the mixture using the following equation according to Fisher [7].

$$LER = Ya + Yb + Yc = Ya/Xa - Yb/Xb - Yc/Xc$$

Where; Ya + Yb +Yc is the total plot yield per unit land area.
Ya, Yb and Yc are the component yields for the three crops.

Xa and Xb are the yields per unit land area where a, b and c are grown under those conditions with which comparisons are to be made.

RESULTS

Maize: Cropping systems had significant effect on average plant height at 12 weeks after sowing (Table 1). The significant reduction in plant height at 12 weeks after sowing was observed in sole maize compared with intercrops. Maize/kenaf/AYB-intercropping system gave the highest average value (2.60 cm) at 12 weeks after sowing. It was observed that maize plant heights in maize/kenaf and maize/AYB intercropping systems were not significantly different from each other. The average grain yields obtained for sole maize, maize/AYB and maize/kenaf intercrops were significantly higher than that obtained in the maize/kenaf/AYB intercrop. The results indicated that, intercropping of the three component crops gave the lowest average value (1.48 t ha^{-1}). The effect of cropping systems on maize grain yield revealed that the sole maize>maize/AYB intercrop>maize/kenaf intercrop>maize/kenaf/AYB intercrop.

Table 1: Average maize plant height and grain yield in kenaf/maize/AYB intercrop

Treatments	Plant height 12 WAS (cm)	Grain yield (t ha^{-1})
Maize/Kenaf/African yam bean	2.60a	1.48c
Maize/Kenaf	2.40b	1.78b
Maize/African yam bean	2.38b	2.47a
Sole maize	2.09c	2.73a

Means with different letters within the same column are significantly different ($p<0.05$)

Table 2: Average kenaf plant height and seed yield in kenaf/maize/AYB intercrop

Treatments	Plant height 12 WAS (cm)	Seed yield (t ha^{-1})
Maize/Kenaf/African yam bean	2.86a	0.71c
Maize/Kenaf	2.33b	0.89b
Kenaf/African yam bean	2.66a	0.99a
Sole Kenaf	2.15c	1.02a

Means with different letters within the same column are significantly different ($p<0.05$)

Kenaf: Cropping systems significantly affected average plant height at 12 weeks after sowing and seed yield (Table 2). Tallest plants were observed under maize/ /kenaf/AYB intercropped, while the shortest plants were observed under kenaf sole cropping. The highest kenaf seed yield (1.02 t ha^{-1}) was recorded under kenaf sole cropping, although, this was not significantly different from that of kenaf/AYB intercropped.

African yam bean: Cropping systems significantly affected the seed yield of African yam bean. Highest seed yields were observed in AYB/maize/kenaf and AYB/kenaf intercropping systems compared to AYB/maize intercropped. Sole AYB had the lowest seed yield (Table 3).

Table 3: Average African yam bean seed yield in kenaf/maize/AYB intercrop

Treatments	Seed yield (t ha^{-1})
Maize/Kenaf/African yam bean	0.86a
Maize/African yam bean	0.64b
Kenaf/African yam bean	0.88a
Sole African yam bean	0.49c

Means with different letters within the same column are significantly different ($p<0.05$)

Table 4: Effect of kenaf-maize-African yambean cropping systems on the Land Equivalent Ratio (LER) in cropping seasons at Ibadan

Treatments	Land equivalent ratio
AYB/Maize/Kenaf	1.12
AYB/Maize/Kenaf	1.06
AYB/Kenaf	1.03

Land productivity: The resultant average Land Equivalent Ratio (LER) values for both years showed high yield advantages due to intercropping systems (Table 4). The LER value that was greater than 1.0, therefore, gave higher production efficiency. The average LER value (1.12) from the maize/kenaf/AYB intercropping system was the highest.

DISCUSSION

The highest maize plant height observed under maize/kenaf/AYB intercropped in this study could be due to the fact that when maize and kenaf were planted at the same time, the maize grew faster and stayed above the kenaf at the early stage. This is because in intercropping system, competition for light by component crops favors component crop with its leaf area higher in the canopy. Therefore, maize in intercropped with kenaf and AYB was at advantage because of its rapid growth rate due to competition for light when compared with maize sole cropping. It was reported that plant height and internodes length increased with increasing plant population because of competition for light [8]. The yield reduction in maize and kenaf obtained with intercropping of maize/kenaf/AYB and maize/kenaf compared with sole cropping of both crops were essentially due to competition from the component crops. Yield reductions involving one or all components in intercropping have been reported by other workers [8, 9]. They attributed such depressant effects to inter-specific competition for nutrients, moisture and/or space. On the other hand, AYB seed yield was significantly higher in maize/kenaf/AYB and kenaf/AYB intercropping systems compared to sole AYB and maize/AYB intercropped. The yield increased might probably be due to the advantageous effects of kenaf to serve as life stakes for the AYB. Intercropping significantly increased seed yield in AYB. However, due to the ability of kenaf to stay for longer period on the field than maize it appeared better in providing support for AYB. Apparently, the sole AYB faced stiffer problem of unavailability of stronger and stable staking materials throughout its physiological growth. The stakes provided could become weak due to the nature of the staking materials, termite infestation and rainstorm. Consequently, yield of AYB was increased with the provision of life stakes like kenaf for its efficient growth throughout its developmental period. The total Land Equivalent Ratios (LERs) obtained with intercropping which were all above 1.0 indicate that higher productivity per unit area was achieved by growing the component crops together than by growing them separately. The relatively high LER values obtained for maize/kenaf/AYB and kenaf/AYB intercrops compared to sole AYB and maize/AYB intercropped could be attributed to the yield benefits in AYB arising form ability of AYB to get life stakes for efficient growth and seed production.

CONCLUSIONS

Consequently, yield advantages were gained by growing maize, kenaf and Africa yam bean together. Due to the additional efforts in providing stake materials for efficient growth and development of AYB, substitutes could be successfully provided when farmers grow AYB with kenaf and/or maize. This will substantially improve growth and yield of the crop and the total yield obtained from other components will apparently compensate for the growing together of the three component crops.

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