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Productivity of Species in Cassava/Maize/Okra/ Egusi Melon Complex Mixtures in Nigeria

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ABSTRACT

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Cassava (*Manihot esculenta* Crantz)/Maize (*Zea mays* L.) intercropping is so popular in Nigeria that a cassava/maize intercropping package is recommended to small-scale farmers. Farmers insist on including low-growing vegetables like okra (*Abelmoschus esculentus* Moench) and egusi melon (*Citrullus lanatus* Thunb.) in the complex. Studies were conducted in Ibadan to investigate the effects of inclusion of either or both vegetables on gross economic yields and total land productivity of the cassava/maize-plus-vegetables mixture.

Tuber yield of cassava in cassava/maize/okra (15.8 t/ha), cassava/maize/egusi melon (15.1 t/ha) and cassava/maize/okra/egusi melon (14.5 t/ha) did not differ significantly from that in cassava/maize (16.4 t/ha). Maize grain yield was not depressed by intercropping with vegetables. The economic yields of intercropped okra and egusi melon were reduced by more than 50% of their respective sole crop yields.

The cassava/maize cropping system yielded highest calories per hectare per day (18.6×10^4 cal ha^{-1} day^{-1}) but land productivity, based on land equivalent ratio (LER), was higher where the cassava/maize system (LER = 1.58) included both okra and egusi melon (LER = 1.60).

INTRODUCTION

In the humid tropics, small-scale farmers, who constitute 70% of the farming population, depend almost entirely on intercropping in order to produce enough food to satisfy their dietary and cash requirements. In such mixtures, more pressure is usually exerted on the microenvironmental growth resources (light, soil nutrients, soil moisture, etc.) than under sole-cropping. Competition which inevitably arises among the components of such mixtures is of considerable importance to the agronomist because of its effects on the economic yields of

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the individual crops as well as the total productivity of the mixture. It is necessary, therefore, to consider crop compatibility in any intercropping system.

In Nigeria, cassava (*Manihot esculenta* Crantz) and maize (*Zea mays* L) are dominant components of many traditional complex mixtures. The cassava/maize package developed and recommended to small-scale farmers (Anonymous, 1977b) was not readily adopted because of the non-inclusion of minor crops which, in traditional mixed-cropping systems, are as important as the base crops. Some of the minor crops frequently grown with casava and maize are egusi melon (*Citrullus lanatus* Thunb.), okra (*Abelmoschus esculentus* Moench) and fluted pumpkin (*Telfairia occidentalis* L). It is now realised that small-scale farmers will not adopt any technology that excludes these essential minor crops. Apart from preliminary work on cassava/egusi melon and cassava/okra mixtures at IITA (Anonymous, 1975, 1977a), little attempt has been made to determine the productivity of major root-crop-based complex mixtures. The study was carried out to determine whether, under technologically improved conditions, the inclusion of egusi melon and/or okra in cassava/maize intercrops actually improves total productivity. Information from this work will reveal the strengths and weaknesses of the cassava/maize recommendation.

MATERIALS AND METHOD

The study was conducted at both the University of Ibadan Research Farm and the International Institute of Tropical Agriculture (IITA), Ibadan between 1981 and 1982. Ibadan lies on longitude 3°51′E and latitude 7°23′N and at an elevation of 200 m above sea level. The soil, which had been under natural fallow for 5 years, was an Oxic Paleustalf with a pH of 6.5 (1 soil: 2.5 water), 1.34% organic matter, 0.09% total nitrogen, 12.63 ppm Brays-1P and exchangeable K, Ca and Mg of 0.38, 3.11 and 0.72 meq/100 g, respectively.

Planting materials

Two improved cassava morphotypes: TMS 30001 (low leaf-area index, *L*) and TMS 30572 (high *L*) were combined with a medium-maturity maize (TZPB, recommended for intercropping), egusi melon and an early-maturing okra. The crop combinations investigated, along with their sole crops, were: (1) cassava/maize/okra/egusi melon; (2) cassava/maize/okra; (3) cassava/maize/egusi melon; (4) cassava/maize; (5) cassava/okra; (6) cassava/egusi melon; (7) cassava/okra/egusi melon; (8) maize/okra; (9) maize/egusi melon; and (10) maize/okra/egusi melon.

Land preparation and layout of experiment

The land was ploughed and harrowed before the crops were planted on the flat. The layout was a split-plot arrangement fitted into a randomized com-

plete-block design with three replicates. The two cassava cultivars formed the main plots, while the crop combinations formed the sub-plots. Each sub-plot size was 8 m×8 m.

Planting

All species were planted on the same day at the beginning of rains. Planting was done on 29 April in 1981 and on 19 April in 1982. A typical stand geometry adopted in this experiment is illustrated in Fig. 1. The plant population of cassava in both sole and mixed plots was 10 000 plants/ha and of maize, okra and egusi melon in sole and mixed plots, 20 000 plants/ha. Egusi melon population was reduced to 10 000 plants/ha in 1982 as it had tended to smother cassava and okra in 1981. For the purpose of determining yield of sole maize, it was planted at 40 000 plants/ha, considered optimum for the maize variety used in this study.

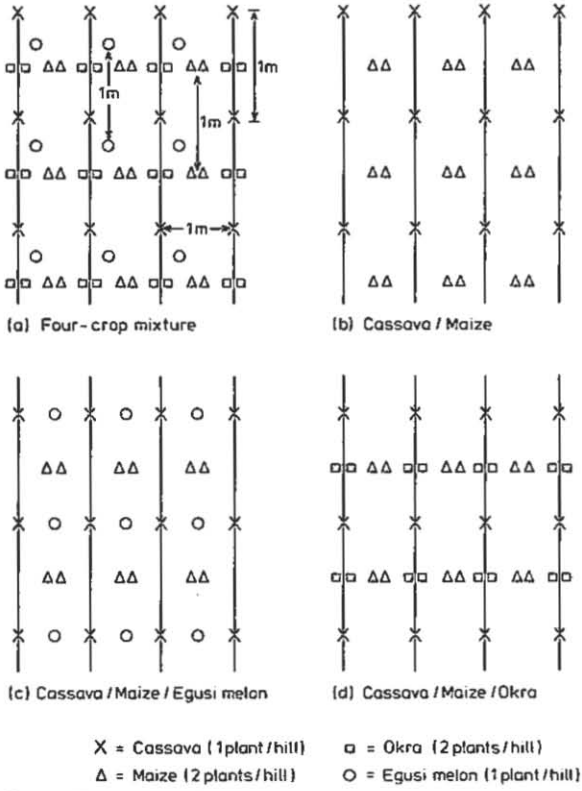


Fig. 1. Typical stand geometry as used in this study.

Routine cultural practices

A compound fertilizer providing 30 kg N, 13 kg P and 25 kg K ha^{-1} in 1981 and twice these amounts in 1982 was applied to each plot 3 weeks after planting (WAP). The lower fertilizer rate used in 1981 was due to the high nutrient status of the experimental area. Plots without egusi melon were weeded twice (3 and 6 WAP) and those with egusi melon only once, at 3 WAP.

Fresh okra fruits were harvested and weighed in the field at intervals of 4 days starting from 7 WAP till cessation of fruiting at 13 WAP. Egusi melon fruits were collected at 11WAP and processed by traditional methods. The seeds were sun-dried and weighed. Maize was harvested at 15 WAP and shelled. Both egusi melon seeds and maize grains were oven-dried at 60°C for 24 h to standardize their dry weights to 14% moisture content. Fresh cassava tuberous roots were harvested 43 WAP and weighed in the field. All weights were extrapolated to yield/ha.

Data analysis

Analysis of variance for a split-plot arrangement of randomised complete-block design was used to assess treatment effects. Means were compared by the Duncan's Multiple Range Test (DMRT) at 5% level of significance. As there was no cultivar × cropping-systems interaction, the mean yields of the two cassava cultivars are presented in this paper.

RESULT AND DISCUSSION

Economic yield of cassava

The mean tuber yields of cassava grown alone or intercropped with maize, okra or egusi melon in 1981 and 1982, are presented in Table 1.

In cassava/okra and cassava/egusi melon mixtures, cassava yield did not differ from that of sole cassava, thus confirming the Anonymous (1975) report. Maize depressed the yield of cassava by about 28% in cassava/maize mixture, even thought the maize population used was only 50% of the optimum for sole maize. Inclusion of either okra or egusi melon or both okra and egusi melon to the cassava/maize intercrops still gave cassava tuber yields comparable to that from cassava/maize. This indicates that the farmer could still produce as much cassava in cassava/maize/vegetables as in cassava/maize alone.

Economic yield of maize

Intercropping did not depress the grain yields of maize (Table 1). Maize grain-yield in maize/cassava intercrops was 26% more than in sole maize at equivalent populations. Sole maize yield at optimum population (40 000 plants/ha) was 3.6 t/ha.

It was interesting to note that maize yield remained high irrespective of type of companion crop. Crookston and Kent (1976) showed that maize and similar

TABLE 1

Mean economic yields[1] of cassava, maize, okra and egusi melon grown alone or intercropped in various combination in 1981 and 1981

Crop Combination	Cassava tubers (t/ha)	Maize grains (t/ha)	Okra fruits (kg/ha)	Egusi melon, dry seeds (kg/ha)
Sole-crop	22.9a[2]	2.6a[3]	1422.6a	709.9a
Cassava/maize	16.4bc	3.1a	—	—
Cassava/okra	22.9a	—	400.2b	—
Cassava/egusi melon	20.0ab	—	—	314.0b
Maize/okra	—	3.0a	199.5c	—
Maize/egusi melon	—	2.8a	—	278.2b
Casssava/maize/okra	15.8c	2.5a	152.8c	—
Cassava/maize/egusi melon	15.1c	2.6a	—	172.9b
Cassava/okra/egusi melon	17.8bc	—	625.6b	214.3b
Cassava/maize/okra/egusi melon	14.5c	2,6a	197.0c	193.5b

[1]Two-year means.

[2]Means followed by the same letter within a column are not satistically significant at 5% level according to Duncan's Multiple Range Test.

[3]Sole maize at 20 000 plants/ha. Maize grain yield at optimum population was 3.6 t/ha.

C_4 plants are suitable for intercropping. Therefore, with adequate moisture and nutrients, intercropping maize with either cassava, egusi melon and/or okra would not be detrimental to maize yields, provided maize population is kept at about 50% optimum.

Economic yields of okra and egusi melon

Mean fresh-fruit yield of okra and dry-seed yield of egusi melon, grown in various crop combinations with cassava and maize, are presented in Table 1. Intercropping reduced yield of okra by more than 50%. Unlike egusi melon which spreads very fast, okra grows slowly and hence a slight shading by a higher-canopy crop would reduce fruit yield. It is probable that tall-growing okra varieties may be more suitable for intercropping than dwarf types, though probably at the expense of other component species.

Fatokun (1976) showed that higher fruit yields from tall-growing, late-maturing okra varieties were a result of greater leaf-area index. The presence of egusi melon slightly improved the fruit yield of okra. This phenomenon was observed by Fagbamiye (1977), but was not explained. As was observed for okra, intercropping reduced seed yield of egusi melon by more than 50%. Egusi melon appears to be more compatible with cassava/maize intercrops than is okra. For example, egusi melon yielded 49% and 40% of sole-crop yield in egusi-melon/cassava and egusi-melon/maize intercrops, respectively, while okra yielded only 28% and 14% with the same companion crops. Also, in egusi-

TABLE 2

Mean land equivalent ratios (LER) and calorie yields of intercropped cassava, maize, okra and egusi melon in 1981 and 1982

Crop Combination	LER	Calorie value (10^4 cal ha^{-1} day^{-1})
Sole cassava	1	10.2
Cassava/maize	1.58	18.6
Cassava/okra	1.28	10.6
Cassava/egusi melon	1.31	10.2
Cassava/maize/okra	1.44	16.9
Cassava/maize/egusi melon	1.57	16.9
Cassava/okra/egusi melon	1.52	10.7
Cassava/maize/okra/egusi melon	1.60	17.4

[1]Two-year means. Computed only for cassava-based mixtures.

melon/cassava/maize intercrops, seed yield of egusi melon was depressed by 76% while in okra/cassava/maize, okra fruit yield was depressed by 90%.

Land equivalent ratios (LER) and calorie yields

The various LER and calorie yields obtained from intercropping systems involving cassava, maize, okra and egusi melon are shown in Table 2. The cassava/maize system is highly productive in terms of calorie yield per unit area per unit time. Inclusion of okra and egusi melon into the cassava/maize system did not further improve calorie yields. The four-crop mixture had slightly lower calorie yields but higher LER than cassava/maize intercrops. This means that although okra and egusi melon did not improve the calorie yields of cassava and maize-based complex mixture, they could improve total productivity per unit area of land. The cassava/maize recommendation could have been based on the high-calorie productivity of the cassava/maize intercrops.

The data of this experiment seem to provide an explanation for the persistence of traditional practice. While dietary requirements are better satisfied, the farmer also saves more land by including vegetables in cassava/maize intercrops. Certain analytical aspects of this investigation will be dealt with in later papers.

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REFERENCES

Anonymous, 1975. International Institute of Tropical Agriculture; 1975. Annual Report for 1974.

Anonymous, 1977a. IITA; 1977. Annual Report for 1976.

Anonymous, 1977b. National Accelerated Food Production Project; 1977. A new dimension for Nigeria Agriculture. Ibadan IITA/FDARD, 80 pp.

Crookston, R.K. and Kent, R., 1976. Intercropping, a new version of an old idea. Crops Soil, 28: 7-9.

Fagbamiye, A.I., 1977. Investigations of traditional mixed cropping and intercropping systems in the tropics. Ph.D. Thesis, University of Ibadan, Nigeria, 365 pp.

Fatokun, C.A., 1976. Genetics and agronomic studies on okra (*Abelmoschus esculentus* (L) Moench), Ph.D. Thesis. University of Ibadan, Nigeria, 256 pp.