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Identification of suitable legumes in cassava *(Manihot esculenta* Crantz)-Legumes intercropping

Legese Hidoto* and Gobeze Loha

Southern Agricultural Research Institute, Awassa Agricultural Research Center, P. O. Box 6, Awassa, Ethiopia.

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Field experiment was conducted at Mekiredi (Amaro research site) in southern nation's nationalities and peoples region of Ethiopia to determine suitable legume(s) in cassava legume intercropping during 2005 to 2008 crop seasons. The experiment was laid out in a randomized complete block design in 3 replications using cassava (cultivar Kelo) and 4 legume varieties including haricot bean (omo95), mung bean (boroda-1), soybean (Awassa-95), and cow pea (Maze). Intercropping cassava with haricot bean, cowpea, soybean and mung bean, reduces cassava yield by 27, 37, 52 and 50% respectively. However, intercropping cassava with haricot bean, cowpea, soybean and mung bean resulted in 82, 49, 48, and 62% greater land use efficiency than for either crop grown alone. Overall land equivalent ratio (LER) was greater than one when cassava intercropped with legumes. This suggested that the actual productivity was higher than expected when cassava was intercropped with grain legumes. Thus, farmers producing cassava have an option to plant with grain legumes such as haricot bean and mung bean so as to obtain alternative crops which minimize risk and use of the land more efficiently.

Key words: Legumes, cassava, intercropping, soy bean, cow pea.

INTRODUCTION

Cassava *(Manihot esculenta* Crantz) is cultivated mainly for its starchy roots and the most important food staple in the tropics, where it is the fourth most important energy source (Alves, 2002). It is generally cultivated by small scale farmers as a subsistence crop in a diverse range of agricultural and food systems (Alves, 2002). The success of cassava in Africa, as food security crop, is largely because of its ability and capacity to yield well in drought prone, marginal wasteland under poor management where other crops would fail. Cassava is a tropical root crop, requiring at least 8 months of warm weather to produce a crop. It is traditionally grown in a savanna climate, but can be grown in extremes of rainfall. In moist areas it does not tolerate flooding. In droughty areas it looses its leaves to conserve moisture, producing new leaves when rains resume. It takes 18 or more months to produce a crop under adverse conditions such as cool or dry weather. Cassava does not tolerate freezing conditions. It tolerates a wide range of soil pH 4.0 to 8.0 and is most productive in full sun.

In Ethiopia, cassava grows in some areas of Southern regions. According to Feleke (1997), cassava was introduced to drought prone areas of Southern part of the country such as Amaro, Gamogofa, Sidama, Wolaita, Gedeo and Konso primarily to fill food gap for subsistence farmers due to failure of other crops as result of drought. In these areas, farmers usually grow cassava in small irregular scattered plots either sole or

*Corresponding author. E-mail: hidotog@yahoo.com.

Table 1. Amount of precipitation in the growing season.

Month	Season			
	2005	**2006**	**2007**	**2008**
January	10.7	1.1	26.8	2.1
February	11.8	43.7	10.9	3.5
March	128.1	107.8	67.4	32.7
April	125.1	146.9	116.1	94.8
May	311.2	310.9	167.4	72.8
June	44.7	39.4	211.6	57.9
July	31.6	8.5	51.2	48.9
August	11.6	131.9	111.3	26.4
Total	674.8	790.2	762.7	339.1

intercropped mainly with taro, enset, maize, haricot bean and sweet potato (Eyasu, 1997).

The average total coverage and production of cassava per annum in Southern region is 4942 ha and 53036.2 tones, respectively [Southern Nations Nationalities and People Region, Bureau of Agriculture (SNNPR, BoA), 2000].

Limited availability of additional land for crop production, decreased soil fertility and declining yield for major food crops have been cited as the major concerns for agriculture's ability to provide nourishment for the increasing population (Sinclair and Gardner, 1998). An advantage commonly claimed for intercropping systems is that, they offer greater yield stability than sole cropping (Mead and Willey, 1980). The system of intercropping is to a great extent practiced in various ways based on the extent of spatial arrangement of the crops on the field (Oguzor, 2007). For subsistence farmers, greater stability in the production of food crops in inter-cropping systems is particularly meaningful, since this characteristic of the production system tends to better insure their sustainability and substantially reduces the risk of total crop loss.

Cassava is a long duration crop that takes more than 9 months for harvest. It is planted at intera and inters row spacing of 80-120 × 60-100 and takes more than 3 to 4 months to develop enough canopies. The available sunlight, water and nutrients between rows can be profitably utilized for short duration intercrops. The main objective of this study was to determine suitable legumes in cassava legume intercropping on yield and land use efficiency of both crops.

MATERIALS AND METHODS

Experimental site

Field experiment was conducted for two successive cropping seasons from 2005 to 2008 at Mekiredi (Amaro) on clay loam textured soil with a pH of 6.5, 0.26% total Nitrogen (N), 39 ppm available phosphorous (P), 40.4 ppm available Potassium (K) and located in an altitude of 1400 masl. The annual average temperature is 21 to 27.5°C. The site has mean annual rain fall ranges from 400 to 800 mm and is bimodal with very short rain season which starts from the last week of February to the end of March and the second season from September to October. The onset of rain may sometimes vary, either too late or too early. The nature of the rain is erratic, and its distribution is uneven (Table 1); whereas, the annual evapotranspiration was from 1400 to 1700 mm.

Plant materials

The study used cassava (Manihot esculenta Crantz cultivar Kelo) and four legume varieties including haricot bean (Omo95), mung bean (boroda-1), soybean (Awassa-95), and cow pea (Maze). Cassava planted using 80 × 80 cm of inter and intra row spacing and two rows of 40 cm apart were left made between the two cassava rows to plant legumes. Seeds of legumes (haricot bean, soy bean, cow pea and mung bean) placed at 10, 5, 10 and 5 cm, respectively. Both crops planted at a time during the first shower of rainfall, February to May.

Treatments and design used

Field experiment conducted using 9 treatments and laid in randomized complete block design in 3 replications. The treatments involved were cassava with haricot bean, cow pea, soybean, and mang bean as intercrop compared with cassava, haricot bean, cow pea, soybean and mang bean as sole.

Observation and measurement

Data of each crop were taken from 5 randomly tagged plants per experimental unit (plots). Root yield of cassava were weighed using spring balance after harvest, and grain yield of legumes was also weighed using ordinary balance. The collected data were subjected to ANOVA using SAS computer software (SAS Institute, 2000)

Land use efficiency was determined by calculating Land equivalent ratio (LER) using (Mead and Willey 1980). Land equivalent ratio of cassava is calculated as intercrop yield of cassava/pure stand yield of cassava and that of legumes is calculated as intercrop yield of legumes/pure stand yield of legumes. The overall LER is simply the sum of LER of cassava and LER of legumes. The competitive value is determined by calculating the ratio of the individual LER's of the two crops.

Table 2. Effect of intercropped grain legumes with cassava on yield of legumes (kg ha^{-1}).

Treatment	Sole yield	Intercrop yield	LER_l	Competitive value
Haricot bean	3510	3822	1.09	1.49
Cow pea	3302	2844	0.86	1.37
Soybean	2010	2010	1.00	2.08
Mung bean	1740	1948	1.12	2.24

Table 3. Effect of intercropped grain legumes with cassava on yield and yield components of Cassava.

Treatment	Roots/plant	Root length (cm)	Root diameter (cm)	Biomass (ton ha^{-1})	Root yield (ton ha^{-1})	LER_c	LER
Cassava + haricot bean	2.7	32	2.98	49.38^b	14.81^b	0.73	1.82
Cassava + cow pea	2.7	36	3.13	35.99^b	12.88^c	0.63	1.49
Cassava+ soybean	2.9	38	2.87	49.29^b	9.71^{de}	0.48	1.48
Cassava + mung bean	2.4	29	2.30	44.25^b	10.26^d	0.50	1.62
Sole cassava	2.9	37	3.48	72.50^a	20.33^a		
Cv%	50.8	27.69	36.09	22.24	31.57		
$LSD_{5\%}$	NS	NS	NS	13.69*	7.24*		

*****Temperature and physicochemical property of the soil of experimental site; NS = not significant; letters in the same column = Significant at 5% probability.

RESULTS AND DISCUSSION

Effect of intercropped grain legumes with cassava on yield of legumes

Intercropping improved yield of haricot bean and mung bean. The probable reason may be due to protection from sun burn by planted cassava stake (Oguzor, 2007). The haricot bean yield improvement of 8% observed when intercropped than sole haricot bean whereas that of intercropped mung bean by 12% than sole mung bean (Table 2). The yield of cow pea and soybean was not favored by intercropping with cassava. This could probable be due to shading effect of these legumes by cassava which resulted in the reduction of photosynthesis which invariably affected the yield of both cow pea and soybean. This result is in line with the finding of Oguzor (2007). He observed that, the yield of soybean was not favored by intercropping with cassava. Cow pea and soybean are the legumes not fevered by intercropping and easily affected by shade than mung bean and common bean, resulted in reduced yield for shade affected legumes. The result is also supported by references.

Effect of intercropped grain legumes with cassava on root yield of cassava and LUE

There was no significant effect of intercropping on number of roots per plant, root length and root diameter of cassava plant (Table 3). Cassava yield was significantly influenced by cropping system. The highest root yield was obtained by sole cropping system. The root yield of cassava is higher when intercropped with haricot bean followed by that of cow pea (Table 3). The land equivalent ratio (LER) was greater when cassava intercropped with legumes. The highest LER was obtained by growing cassava with haricot bean (1.82) followed by cassava with mung bean (1.62) whereas relatively the lowest was cassava with soybean (1.48). As indicated by the report of (Oguzore (2007), the probable reason might be due to the fact that the shade effect of cassava on soybean hindered photosynthetic activity of the soybean which resulted in low soybean yield.)

Intercropping cassava with haricot bean, cowpea, soybean and mung bean, reduces cassava yield by 27, 37, 52 and 50%, respectively. However, intercropping cassava with haricot bean, cowpea, soybean and mung bean resulted in 82, 49, 48 and 62% greater land use efficiency than for either crop grown alone. This result is in line with the findings of (Mason et al., 1986). They found out that intercropping cassava with cowpea reduces cassava yield by 14 to 24%. Masone and Lehiner (1988) also reported that, intercropping cassava with cow pea reduces cassava yield by 19 to 38%. However, intercropping cassava with cowpea resulted in 20 to 100% greater land use efficiency than for either crop grown alone (Leihner, 1983). This finding supports the result of this study. The land use efficiency improved by 82% when cassava intercropping with haricot bean and that of mung bean was by 62% indicated that, the actual productivity was higher than the expected when cassava was intercropped with legumes. This result is in line with the finding of Okoli (1996). He found out that, cassava cowpea intercropping system increased land use efficiency by 9 to 40%. The same result was reported by Mason et al. (1986). They reported that, cassava/legume intercropping system resulted in greater land use efficiency.

CONCLUSION AND RECOMMENDATION

In conclusion, this study has shown that the land use efficiency improved by 82% when cassava intercropping with haricot bean and that of mung bean was by 62% and the lowest was with soybean and is by 48% which indicated that the actual productivity was higher than expected when cassava was intercropped with legumes. Thus, intercropping cassava with legumes is important to cassava farmers since it would provide additional crop yield during the early cassava growth stage with the same piece of land. Obtaining additional food grain is an attractive option for the farmers having land shortage to plant cassava and legume separately. The benefit of obtaining additional legume grain would have positive advantage on food security and land use efficiency. However, it needs further study on the effects of legumes in cassava/legume intercropping on soil physicochemical properties.

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