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EVALUATING RECIPROCAL STRESSES BETWEEN CLIMBING BEANS AND CASSAVA-STAKE FOR CLIMBER BEANS STAKE

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ABSTRACT

In the mountainous area at East of Democratic Republic of Congo (DRC) cooking woods is an acute problem. Cassava fresh stems of about 120 to 150 cm long are utilized to sustain climber's production, an important staple food proteins provider. It was desired to assess the effect of using climbing beans as an intercrop with cassava on the yield of the two crops. Four treatments involving two varieties of climbing beans and one variety of cassava were tried: i) cassava's stems support climbers growth one growing season, ii) two growing seasons in a row, iii) three consecutive growing seasons and iv) the control treatment or cassava sole crop non-staking climbers. Eighteen month later results were: Climbers yield appreciably in mixed crop cassava-climbers with cassava- stakes for climbers. Climbers' Yields decrease during the second and third season. High yields of climbers on cassava-stakes generate stresses on cassava growing plants. Theses reduced cassava's yield in terms of fresh tubers weight reduction of about 6.6 to 19.7% for climbers' varieties Namulenga and 8.2 to 18.5% for climbers' variety G59/1-7 from the first to the third season. Climbers also lose their yields over consecutive staking seasons on cassava-stakes. These losses ranked from 3.02 to 11.35%, and 11.57 to 35.51%, for climbers variety Namulenga and variety G59/1-7, respectively when staked two and three consecutive seasons. Yield losses are observed on both cassava variety and climbers beans varieties. So, stresses are reciprocal on cassava and climbers beans cultivars in their intercropping.

Key words: Cassava stake, climber beans, staking season, stress, yield loss

INTRODUCTION

Cassava *(Manihot esculenta* Crantz) is cultivated mainly for its starchy roots and is 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 diverse range of agricultural and food systems (Alves, 2002).

In the humid tropical zone of West and Central Africa, cassava is a major food crop often intercropped with annual crops which mature earlier. The latter crops may be cereals (Ezumah and Okigbo, 1980); grain legumes (Balasubramanian and Sekayange, 1990) or vegetables (Ikeorgu e all/., 1989). Among the grain legumes commonly intercropped with cassava are peanuts *(Arachis hypogea)* (Lutaladio, 1986), beans *(Phaseolus vulgaris)(Oscar arogoces,Luz MariaMedina, ,(1987)* (Balasubramanian and Sekayange, 1990), pigeon peas *(Cajanus cajan)* (Okigbo, 1977), and cowpeas *(Vigna unguiculata)* (Juo and Ezumah, 1991).

The intercropping is interesting in relation to sole cropping, for several reasons: intensive use of the area, vegetative soil protection against erosion and improvement of weed control. The disadvantages are due to the increase of skilled labor and competition between the species (BAUMANN et al., 2001).

Because of the few studies on this subject, therefore, in the scientific area, occurs the challenging of information about results found in intercropping systems and spatial arrangements. Flesch, (2002) states that intercropping provides more agronomic and economic advantages than sole crops. Albuquerque *et al*. (2012) states that usually, yields in sole culture is superior to those of intercropping.

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.

MATERIALS AND METHODS

Experimental location and vegetal materials

Field experiment was conducted at National Institute for Agricultural Study and Research (INERA) Mulungu in three consecutive seasons, from September 2012 to February 2014 to determine the appropriate period of intercropping cassava and climbing beans on the yield. One cassava variety namely, Sawasawa and two climbing beans varieties, Namulenga and G59/1-7 were used in the study.

Table 1. Characteristics of experimental site

Characteristics	Value
Altitude (m)	1750
Annual mean rainfall (mm)	1650
Annual mean temperature	19^{o}C
Relative humidity	74%
Soil type	SMAG
Mean pH	5.3

Source: Meteorology station, INERA Mulungu; SMAG= sols de marais à argile gonflante

Experimental design and treatments

The experiment was laid out using a split-plot design with three replicates in three seasons. The treatment consisted of crops of cassava and climbing beans planted in intercropping. The experiment consisted of two factors as follow:

Factor A: Number of times cassava stakes climbers during its full growing cycle, with four variables:

- 0X= Cassava sole crop, not bearing climbers
- 1X= Cassava bearing climbers crop one season during its full growing cultural cycle
- 2X= Cassava stakes climber two consecutive seasons during its full growing cultural cycle, and
- Cassava plants stake climbers three times in a row during its growing cycle.

Factor B: Climbing beans varieties with two variables:

- Namulenga variety
- G59/1-7 variety

Statistical analyses

Statistical analysis was performed separately for the two cultures. The results were submitted to analysis of variance using the F test at 5% probability and the averages compared by the test of Tukey at 5% probability.

RESULTS AND DISCUSSION

Yields of climber supported once and twice in a row by cassava stems, as stakes are alike but significantly (P=0.01) different with that of climber staked three growing season support in a row (Table 2) by LSD. On the side of cassava mean yields between sole crop and staking once are the highest yields alike in the first homogenous group while staking once and twice in a row seems to produce same yield in either climber side or cassava side, on as the second homogenous group. Sole cassava crop in one hand produced the least Climber yield (0.000 Kg) because it was not mixed crop with climber. For the same reason it produced one of the highest yields of fresh tuber roots comparable to that of staking once climber beans. Furthermore, staking climber three times in a row gives yields alike for both climber and cassava. Finally it is noticed that cassava yields are highly and significantly different between cassava sole crop and cassava utilized as climbers' stakes two and three consecutive climber's growing seasons this could be due to stresses imposed by climbers on cassava plants. This trend is also observed on climbers according to number of seasons climbers are staked by cassava (Table 2).

Table 2: Comparison of average yields of climbers and cassava with cassava as stakes for climbers

Number of seasons cassava stems bear climber's growth as stake	Climber mean yields (Kg /ha)	Cassava mean yields when used as stake in intercropping with	
		Namulenga	G59/1-7
0 season	0.0 [c]	31180.6 [a]	30834.0 [a]
1 season	1446.4 [a]	29696.0 [ab]	28319.0 [ab]
2 seasons	1402.7 [ab]	27150.0 [bc]	27127.0 [bc]
3 seasons	1282.2 [b]	25526.0 [c]	25128.0 [c]
CV (%)	7.3	1.6	1.5
LSD (0.01)	156.6	1891.9	1891.9

Columns of Climber yield means and cassava yield means with similar letter are not significantly (P=0.01) different.

Climbers and cassava yield differences according to variety and seasons

All climber varieties do not react uniformly toward cassava stems as stake. This reveals possible genetic differences concerning yield potentiality, and highly possible interaction between climber's varieties and cassava physiology of vegetative plant as stake (able 3) . On the cassava side yield means of cassava vary according to the climber's variety staked. This fact could be due to the degree of varietal aggressivity of climber when competing for vital resources, such as solar radiations and soil nutrients...

On the climber side, all climber varieties do not react uniformly toward cassava stems as stake. This reveals possible genetic differences concerning yield potentiality This confirms what(Davis, J.H.C. and Garcia S,1983) found when maize was intercropped with common beans climbers., and highly possible interaction between climber's varieties and cassava vegetative plant as stake.

Table 3. Comparison of climber's variety yields and cassava yields according to the climber variety staked.

Variety of beans	Mean yield of Climber Variety (Kg/ha)	Mean cassava yield (kg/ha)
Namulenga	1093.5 [a]	28624 [a]
G59/1-7	982.2 [b]	2785 [b]
CV%	1.55	1.55
LSD 0.01	104.01	600.21

Visioning cassava's and climbers' yield losses according to climbing variety staked and number of seasons climbers are staked

It is clearly shown that cassava utilized to stake climbers, and staked climbers over several consecutive seasons undergo stresses that result in cassava yield loss which averages 6.6 to 19.7% for climber var. Namulenga, and 8.2 to 18.5% for climber var. G59/1-7 (Table 4). For such yield loss causes could be either potential varieties genetic differences or varietal aggressivity in searching vital nutrient resources such solar radiation, CO_2 and soil nutrients. These causes seem to explain also why yields of climbers decrease staking season after staking season 3.02 to 11.35% on climber var. Namulenga, and 11.57 to 35.51 for climber var. G59/1-7. This fact is possible because cassava fresh stem regenerate a cassava living plant which is physiologically active in developing abundant leaves with a high leaf area index (LAI), roots and branches. All climbers' varieties do not respond similarly to conditions imposed on them by cassava.This depends on the morphology of beqn climber type(FernandoFernandez O., Adriana Correa J.B., 1986) which has become the dominant crop in the intercropping (table 4).

Table 4. Clear presentation of cassava yield loss of tuber roots related to climber varieties staked by cassava, and climbers' varieties yield losses over consecutive staking seasons.

Variety	Number of seasons cassava stakes climber	Yields of climbers staked by cassava over seasons	Yield loss of climbers staked by cassava over seasons (%)	Yield of cassava as stake (Kg/ha)	Cassava's yield loss (Kg/ha)	Percent of cassava's tuberous root weight loss
Namulenga	0 season	0.0000 [c]	-	31806.0	0.0	0.0
	1 season	1446.4 [a]	0.00	29696.0	2110.0	6.6
	2 seasons	1402.7 [ab]	3.02	27150.0	4656.0	14.6
	3 seasons	1282.2 [b]	11.35	25526.0	6280.0	19.7
G59/1-7	0 season	0.0000 [d]	-	30834.0	0.0	0.0
	1 season	1490.9 [a]	0.00	28319.0	2515.0	8.2
	2 seasons	1318.4 [b]	11.57	27127.0	3707.0	12.0
	3 seasons	961.5 [c]	35.51	25128.0	5706.0	18.5

CONCLUSIONS

Common beans, climber type is able to produce appreciably good grain yields when intercropped with cassava one to three seasons in a row or in other words when climber is staked by cassava growing plant during three climber cropping cycles.

1. Climbers suffer from stresses imposed by cassava. Climber beans yield losses rank from 3.02 to 11.35%, and 11.57 to 35.51% for var. Namulenga and var. G59/1-7.
2. Cassava plant as stake the later undergo yield loss of about 6.6 to 19.7% when it stakes climber var. Namulenga, and 8.2 to 18.5% when it stakes climber var.G59/1-7.
3. On the three consecutive growing seasons of climbers being staken by cassava staking once causes minimal loss to cassava yield, but it gives the climber's highest grain yield.
4. Any number of season's cassava is used as stakes for climber beans, it causes climbers dry grains yield loss with the least loss for staking once.
5. Yield losses are observed on both cassava and climbers beans varieties. So, stresses are reciprocal on cassava and climbers in their intercropping.

The extend of the stress undergone by cassava depends on the climber's variety mixed crop with cassava.

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