Determination of the Appropriate Time of Relaying Cassava into Pepper in Intercropping System in Nigeria

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ABSTRACT: Relay intercropping of cassava (*Manihot esculenta* Crantz) into pepper (*Capsicum annum* L.) is a common practice among farmers in Nigeria. However, there is high variation in the time of the relay thus leading to variability in yields of cassava and pepper. Field experiments were conducted to determine the appropriate time to introduce cassava into pepper in a relay intercrop. The experiment was a randomized complete block design replicated three times. Five different planting dates of relaying cassava into pepper were evaluated . Pepper and two cassava varieties were the test crops. Sole pepper was included for comparison. Delayed relay planting of cassava into pepper beyond 1 MAT (Months after transplanting) adversely affected the yield of both cassava varieties while simultaneous planting of pepper and cassava significantly ($P \leq 0.05$) delayed flowering and maturity of pepper with a resultant effect of significant ($P \leq 0.05$) reduction in fruit yield of pepper. The most appropriate time to introduce cassava into pepper in a relay intercrop was 1 MAT.

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INTRODUCTION

Pepper (*Capsicum annuum L.)* is the second most important crop after tomato (*Lycopersicon esculentum*) among the family *Solanaceae*. Pepper is usually grown in various combinations with other food crops like maize (*Zea mais)*, yam (*Dioscorea spp.*) and cassava (*Manihot esculenta* Crantz) in traditional cropping systems.

Cassava is the main staple food for 40 % of the population in West and Central Africa (FAO 1998).The plant is highly adapted to various edapho-climatic conditions and serves as a major source of starch to the people in tropical Africa. It is an important crop commonly grown in mixtures with other crops on the field by farmers in Nigeria.

Few studies reported on the performance of pepper in intercropping. Manu-Aduening and Boa-amposem (1998) reported that maize and pepper components showed differences in plant height, and the extent of leaf conductance was higher than in sole crops in three spatial arrangements of yam-maize-pepper intercrop. In Nigeria, some subsistence farmers plant pepper as sole crop, while others relay cassava into pepper when the harvesting of pepper fruits is nearing completion. The delay in the introduction of cassava usually leads to its poor establishment and exposure to attack by pests and diseases at the onset of the dry season. The compatibility and the appropriate time to interplant these two crops are yet to receive adequate research attention. This study was designed to determine the appropriate time to introduce cassava into pepper crops.

Materials and Methods

Field experiments were conducted at the Research Station of Oyo State Agricultural Development Programme (OYSADEP) in Ogbomoso during 2001 – 2003 cropping seasons. Ogbomoso lies on latitude 8° 01' N, longitude 4° 06' E, about 310 m above sea level in the derived savannah belt of south-western Nigeria.

The mean annual rainfall of the experimental station during the period of the experiment was 1,062 mm with high intensity over a period of seven months (April to October). The land used for the experiments had been previously cropped to staple food crops such as cassava, maize, yam and guinea corn. Composite samples of the topsoil (0 – 15 cm depth) were taken from the site and analyzed for their physical and chemical properties (Table 1) before the commencement of the experiment in each year.

The experiment was a randomized complete block design replicated four times. Five different planting dates of relaying cassava into pepper were evaluated. Pepper and two cassava varieties were the test crops. Sole pepper was included for comparison. Each plot measured 5 m x 4 m with 1 m gaps between plots and 2 m margin between blocks to facilitate field

operations. Pepper cultivar NHVI-B, released by the National Horticultural Research Institute (NIHORT) was used. Pepper seedlings were raised in nursery beds measuring 1.2 x 10 m^2. Sowing was done in drills of about 2 cm deep at 10 cm apart. Six-week old seedlings were transplanted into the crest of the ridges and cassava stem cuttings of about 20 – 25 cm length were planted at the side of the ridges. . Two cassava varieties namely TMS30572 (improved) and Oko *iyawo* (a local variety) were used in the study. The pepper crops were planted in mid June in each year and cassava was relayed into the pepper crops at the five planting dates namely; 0MAT (mid-June, simultaneous planted with pepper), 1MAT (mid- July), 2MAT (mid-August), 3MAT (mid-September), and 4MAT (mid-October). The usual planting dates of cassava in the study area ranges between mid May to late July in relation to rainy seasons. Cassava was planted at 1 m x 1 m and pepper at 1 m x 0.5 m spacing. Plant population density was thus 10,000 per hectare for cassava and 20,000 plants per hectare for pepper. Hoe weeding was done each time cassava was introduced into pepper plots with an average of four weedings carried out before total harvesting of both crops.

Ten plants of the cassava and 15 plants of pepper were randomly sampled from the net plot to record observations adopting the partial replacement procedure by Gomez and Gomez (1984). Days to 50 % flowering were recorded. Numbers of days to first time of harvest were recorded from sowing date to the time of picking the first fully ripe fruits of pepper. Ripe fruits of pepper were harvested at weekly intervals. Number of fruits per plant was obtained from randomly selected plants/plot while the cumulative fresh weight of the total fruits picked from the net plot (12 m^2) was recorded. Fruit length was obtained from 30 randomly picked fruits using transparent ruler. Residual harvest of pepper was carried in the following season. Total root yields of cassava from the net plot (12m^2) were recorded at 12 MAP Data were analyzed using ANOVA.

RESULTS

Fresh fruit yield of pepper

Fresh fruit yields of pepper recorded in the treatments where the cassava varieties were planted simultaneously with pepper were significantly ($P \leq 0.05$) lower than those recorded for other treatments. Sole pepper produced the highest fruit yield of 4.6 t/ha, about 309 % more than the fruit yield of 0.9 t/ha recorded in pepper plots where TMS30572 was introduced at 0 months after transplanting (MAT) in 2001/2002 cropping season. Similar trend was observed in 2002/2003 cropping season (Figs. 1 &2).

Flowering and days to first time of harvest

Pepper plots in which cassava was introduced at 0 MAT required 6 – 7 more days to attain 50 % flowering, as compared with other treatments in both years. Similarly, pepper took an average of 151 days to reach first time of harvest when both cassava varieties were relayed into pepper at 0 MAT this was significantly ($P \leq 0.05$) higher than the average of 143 days required by other treatments (Table 2). Sole pepper gave the highest number of 27 fruits per plant which was about 375 % higher than number of fruits per plant recorded under TMS30572 relayed into pepper at 0 MAT. However, introduction of both cassava varieties at 1, 2, 3 and 4 MAT had no significant ($P > 0.05$) effect on fruit length of pepper in both years (Table 3). Residual harvest of pepper fruits recorded in the following season showed significant differences across the treatments with the highest yield recorded where TMS30572 was introduced at 2 MAT in the two successive cropping seasons (Figs. 3 & 4).

Cassava root yield

Fresh root yield of cassava decreased significantly ($P < 0.05$) with progressive delay in the time of relaying cassava into pepper in both years of the experiment. The highest fresh cassava root weight of 20.30 t/ha was recorded from the treatment with introduction of *Oko Iyawo* at 0 MAT followed by treatment with introduction of *Oko Iyawo* at 1 MAT with a fresh tuber yield of 19.4 t/ha but they were not significantly different ($P > 0.05$) from each other (Figs. 5 & 6).

DISCUSSION

Introduction of cassava at the late-vegetative or early reproductive stage of pepper did not adversely affect fresh fruit yield of pepper. Conversely, the low fresh fruit yield recorded for pepper when simultaneous planted with cassava may be attributed to competitive interaction between both crops at earlier stages of crop growth. Lowe *et al*., (1982) also reported that root bulking in cassava was visible at 6 weeks after planting; a stage at which the cassava could had probably started competing with pepper. Intercrop competition, according to Palaniappan (1985), occurs essentially in a response of one species to the environment as modified by the presence of another species. Crop competition could be minimised by spatial arrangement and choosing crops best able to exploit soil nutrients, and with different times of maturity, thereby separating periods of maximum demand of growth resources above and below ground.

Table 1. Selected pre-planting physico-chemical characteristics of soil of the experimental sites (0 – 15 cm depth)

Soil Properties	**2001**	**2002**
pH (H_20)	6.70	6.70
Organic Carbon (g kg^{-1})	0.39	0.51
Total N g kg^{-1}	0.040	0.051
Available P (mg kg^{-1})	8.05	7.35
Exchangeable Bases		
cmol kg^{-1} soil		
Ca	2.33	2.03
K	0.13	0.12
Na	0.60	0.61
Exchangeable Acidity	0.14	0.28
C. E. C.	2.84	2.56
Physical Properties		
Sand (g/kg)	781	798
Clay (g/kg)	65	58
Silt (g/kg)	154	144

Table 2. Effects of different times of relaying two cassava varieties into pepper on 50% flowering of pepper and first time of harvest

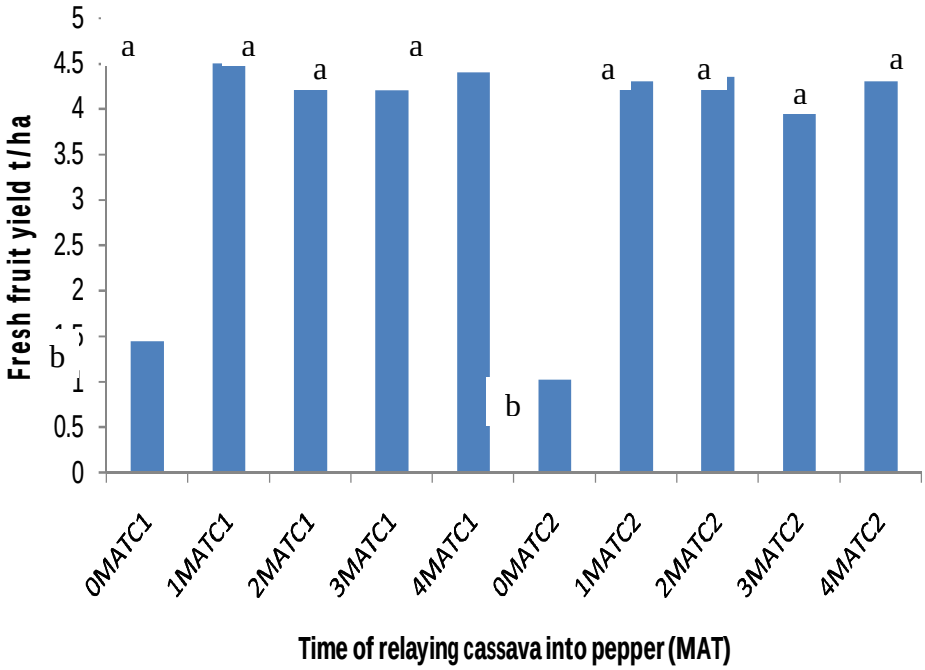
Cropping system	**Days to 50% flowering**		**Days to maturity**	
	2001/2002	**2002/2003**	**2001/2002**	**2002/2003**
P Sole				
0 MAT	87c	87c	143c	143c
P + C1				
0 MAT	95a	95a	150a	152a
P + C1				
1 MAT	88b	89b	143c	144bc
P + C1				
2MAT	86c	87c	142d	145b
P + C1				
3 MAT	88b	89b	143c	143c
P + C1				
4 MAT	88b	88bc	143c	143c
P + C2				
0 MAT	92a	94a	151a	151a
P + C2				
1 MAT	88b	88bc	143c	143c
P + C2				
2 MAT	89b	88bc	142d	142d
P + C2				
3 MAT	88b	87c	144b	144b
P + C2				
4 MAT	87c	87c	144b	143c

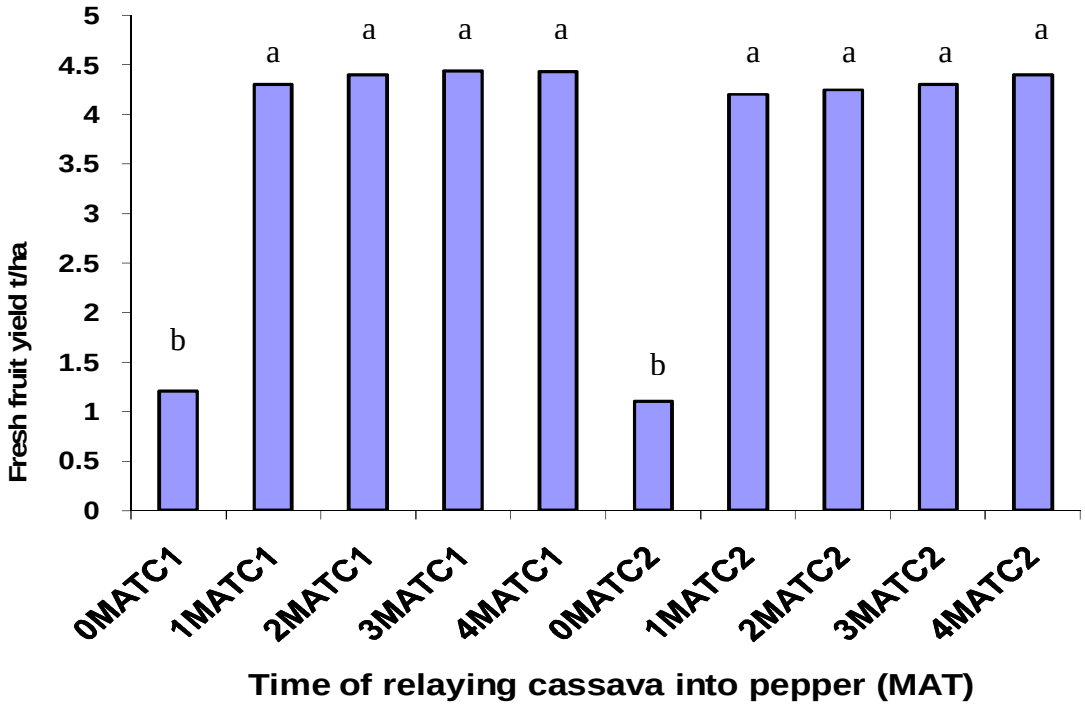
Means in the same column followed by the same letters are not significantly different at p<5% according to Duncan's multiple range test.
P = Pepper; C1 = *Oko Iyawo*; C2 = TMS30572, 0, 1, 2, 3, and 4 are
MAT: Months after transplanting

Table 3. Effect of different times of relaying two cassava varieties into pepper on number and fruit length of pepper

Cropping system	Fruit length (cm)		No. fruits/Plant	
	2001/2002	2002/2003	2001/2002	2002/2003
P Sole				
0 MAT	9.9a	9.7a	27a	27a
P + C1				
0 MAT	7.6b	7.4b	7c	6c
P + C1				
1 MAT	9.3a	9.3a	25b	26ab
P + C1				
2MAT	9.7a	9.4a	26ab	26ab
P + C1				
3 MAT	9.3a	9.2a	25b	25b
P + C1				
4 MAT	9.4a	9.3a	27a	26ab
P + C2				
0 MAT	7.5b	7.4b	6c	6c
P + C2				
1 MAT	9.6a	9.2a	25b	26ab
P + C2				
2 MAT	9.5a	9.6a	26ab	25b
P + C2				
3 MAT	9.6a	9.7a	25b	26ab
P + C2				
4 MAT	9.5a	9.6a	26ab	27a

Means in the same column followed by the same letters are not significantly different at p<5% according to Duncan's multiple range tests.
P = Pepper; C1 = *Oko Iyawo*; C2 = TMS30572, 0, 1, 2, 3, and 4
MAT: Month After Transplanting





In this study competition was reduced by introducing cassava into pepper at 1 MAT of pepper which probably did not coincide with period of critical demand for growth resources, especially light, nutrient and water Effect of shading on the growth and yield of pepper had been reported (AVRDC 1997). Okoli et al. (1996) also observed that the longer the delay in introducing cowpea into cassava, the greater was the shading effect of the well established cassava genotype on cowpea.

Mutsaers *et al.* (1993) opined that crop combinations where cassava yield was least affected by competition were the most efficient ones. In this study, the yield decline recorded in cassava planted at later dates was probably due to negative effects of water deficiency in relation to rainy season and shift in planting dates of cassava experienced during vegetative and root development stages. Earlier report by El Sharkaway et al. (1998) indicated that early and mid-season water stresses significantly reduced top and root biomass than late or terminal stress that may occur at the maturity stage in cassava. The findings of this study also agree with that of Agbaje and Akinlosotu (2004) that variation in time of planting, which resulted in yield difference, was due to severe stress suffered by late planted cassava at both the vegetative stage and root initiation. The practical significance of productivity in intercropping could only be fully assessed when related to monetary returns (Willey, 1979). In this study, introducing cassava into pepper at 1 MAT had lowest cost benefit ratio compared to other stages of relaying cassava into pepper, indicating cost effectiveness of the practice. Therefore, cassava should be relayed into pepper at 1 MAT under the circumstances prevailing at the study site.

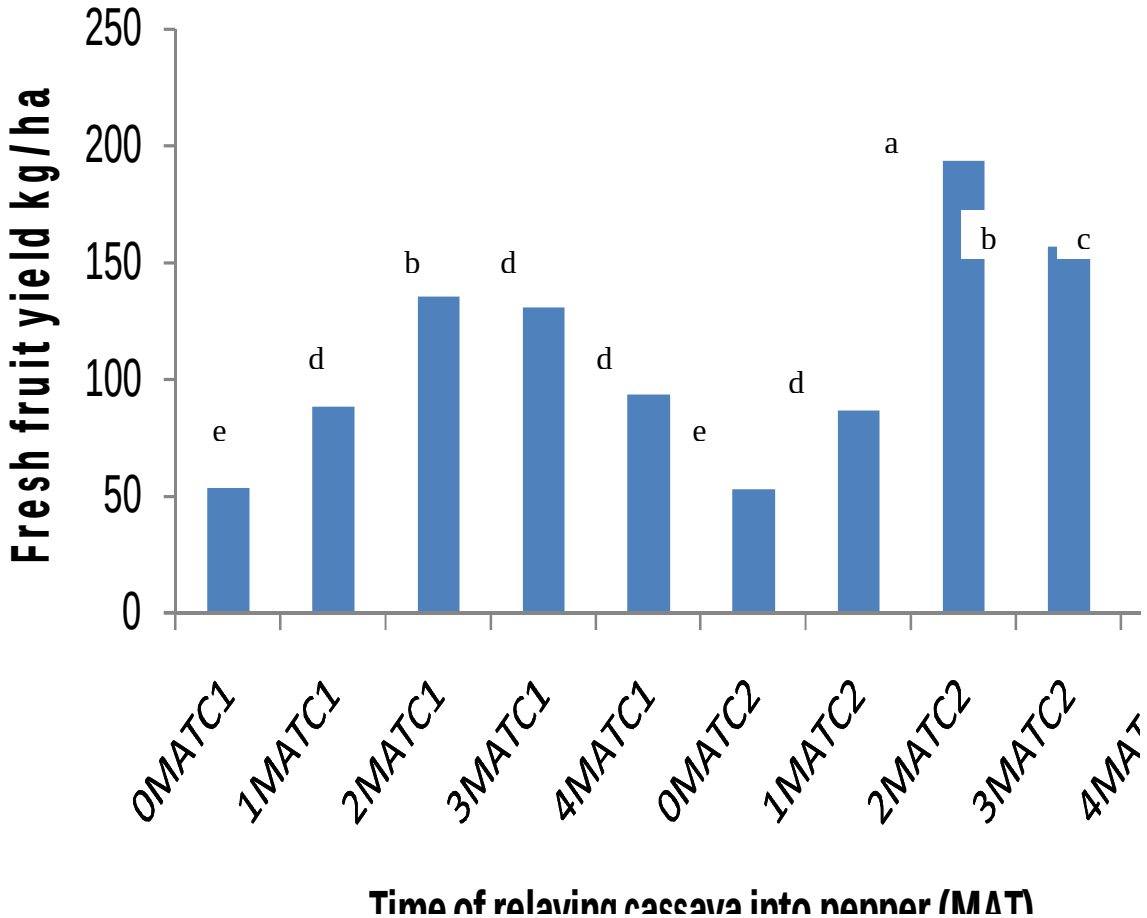
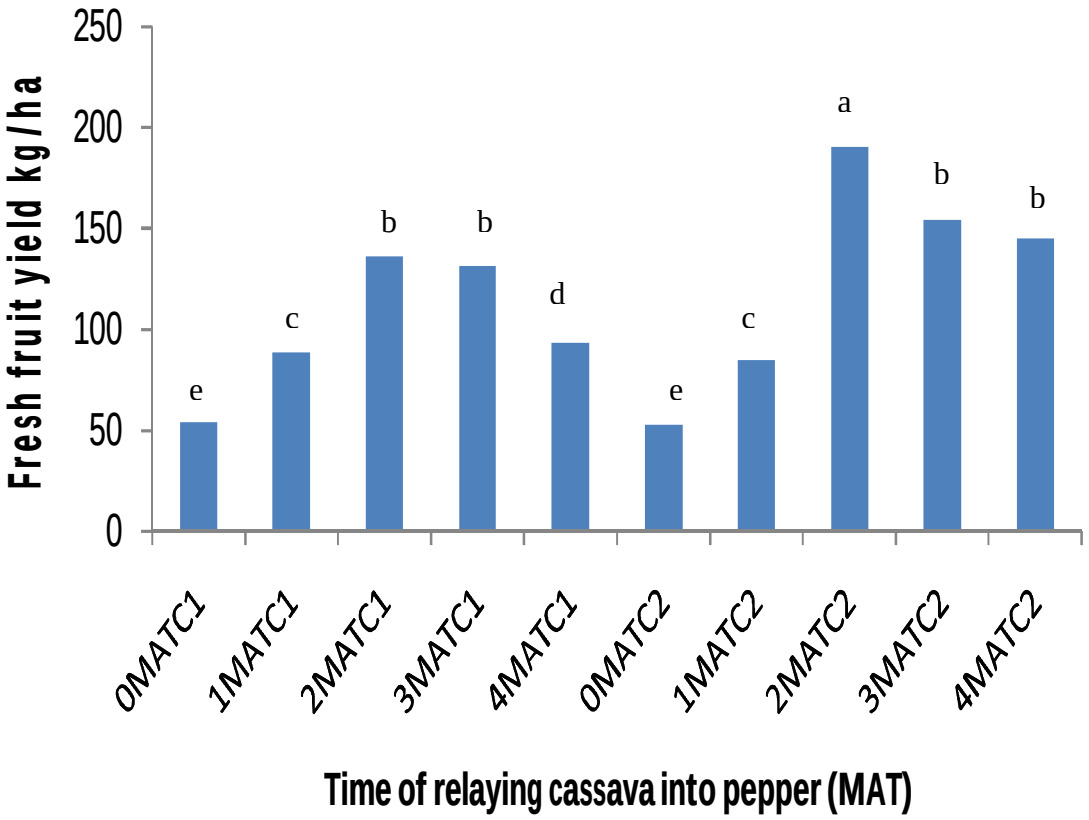


Fig. 3 .Residual harvest of pepper in the second season as affected by different times of relaying cassava into pepper (2001/2002) cropping season.

Bars labelled with the same letter are not significantly different by DMRT at 5 % probability level.. C1= *Oko Iyawo*; C2 = TMS30572; 0, 1, 2, 3, and 4 are MAT = Months after transplanting



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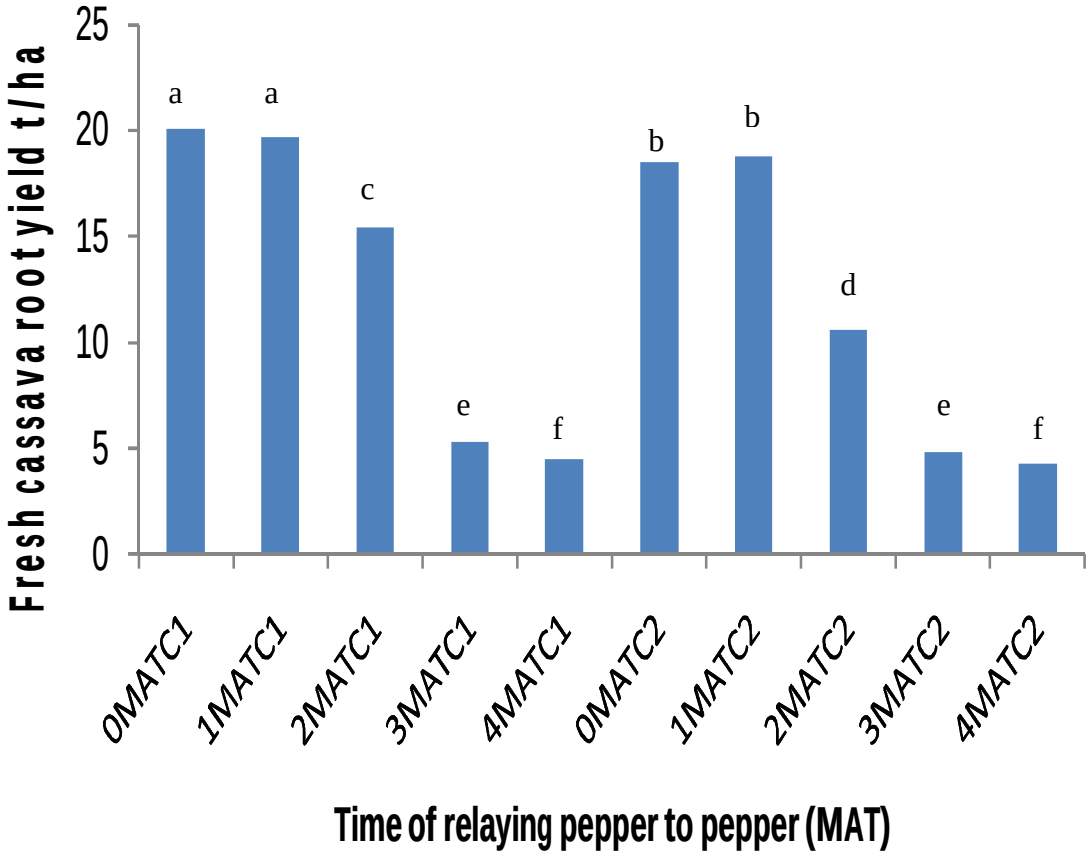
Fresh cassava root yield t/ha
25
20
15
10
5
0
a
a
c
e
f
b
b
d
e
f
0MATC1
1MATC1
2MATC1
3MATC1
4MATC1
0MATC2
1MATC2
2MATC2
3MATC2
4MATC2
Time of relaying pepper to pepper (MAT)

9/19/2010