

Intercropping Cocoa with Rice and Plantain Influencing Cocoa Morphological Parameters and Weed Biomass

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Abstract: A field study was conducted at CRIN Uhonmora Substation, Edo State in Derived Guinea Savanna Zone of Nigeria between 2007 and 2008. The experiment determined influence of intercropping cocoa with rice and plantain at early stage of field establishment. Four treatments considered were cocoa (sole), cocoa/rice, cocoa/plantain and cocoa/rice/plantain. Spacing of 3.1 m apart was used for cocoa and plantain while rice was 30 cm. Plot laid out was randomized complete block design replicated three times. Data on cocoa morphological parameters comprising plant height, girth and leaf area as well as weed biomass were measured monthly. Cocoa survival count was also determined. Data collected were subjected to ANOVA, and LSD was used to separate the means. Survival count showed over 95% survival in all treatments without any significance differences. On plant height and leaf area vegetative growth were significantly higher ($P < 0.05$) in the intercrops than the sole cocoa but not significantly different in all the months. Plant vigour was significantly higher in cocoa/plantain intercrop. Cocoa/rice/plantain produced the least weed biomass while cocoa sole gave the highest. Therefore, cocoa/rice and cocoa/plantain intercrops could be recommended to cocoa farmers in Nigeria instead of sole planting at early age of field establishment.

Key words: Cocoa, intercropping, morphological parameters, weed.

1. Introduction

Intercropping is the planting of two or more crops simultaneously on the same piece of land, which is most practiced among the various forms of multiple cropping. Intercropping had been reported to increase crop diversity, biological stability of the ecosystem and labour efficiency [1]. Many tree crops notably oil palm, cocoa, kola and coffee have been successfully intercropped with other tree and food crops [2-4]. Intercropping in cocoa that was carried out to provide foods for the famers and income in Nigeria is usually practiced at the juvenile stage when their leaf canopies have not completely closed. However, majority of farmers involved in cocoa production in Nigeria do not practice intercropping with rice despite the various advantages derivable from it either because they are

not familiar with the technology or are still sticking to previous education by the colonial change agents of monocultural production of cocoa in Nigeria [5]. Rice had been reported to be successfully grown as cover crop in young coffee, cacao, citrus and rubber trees in Japan, Brazil, Ivory Coast and Thailand [6]. For the cocoa farmers in Nigeria to combat world food crisis, get adequate income at the initial establishment stage of the crop and further their production for higher productivity, there is need for them to intercrop cocoa with a number of arable crops. The objective of this study was to evaluate the performance of cocoa intercropped with rice and plantain at juvenile stage on the field.

2. Material and Method

2.1 Material

The experiment was carried out at CRIN Uhonmora Substation, Edo State, Nigeria in derived guinea

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savanna zone between Latitude 6°5' and longitude 5°50' E in the year 2007 and 2008. The cocoa seedlings were raised from F₃ Amazon cocoa pods and plantain suckers obtained from Plot D₂ in the substation. Local rice variety was obtained from Ekpoma market, a community noted for Ekpoma rice production in Edo State, Nigeria.

2.2 Method

The experimental design was randomized complete block (RCB) with four treatments comprising of cocoa sole, cocoa/rice, cocoa/plantain and cocoa/rice/plantain replicated three times. Cocoa and plantain were planted one per stand with planting distance of 3.1 m apart with plantain stand in between a cocoa stand. Rice was planted twice throughout the trial. Quadrant of 30 cm × 30 cm square was used for collecting weed samples. A quadrant was taken per treatment before each period of weeding.

2.3 Data Analysis

Data collected include plant height, plant girth, leaf area, fresh and dry weight of the weed sample after oven drying for 72 hours to a constant weight of 85 °C. Yield of rice (grain) and plantain (bunch) were also collected and their weight determined using weighing balance. Data collected were subjected to statistical analysis of variance and LSD was used to separate the mean that were significant.

3. Results and Discussion

The survival count carried out two months after transplanting showed a survival rate of over 95% in all

the treatments without any significance difference between them.

The plant height of the different intercrops was shown in Table 1. The plant height was higher between September and November 2007 in cocoa/plantain than other treatments but the trend change in December with coffee/rice taken the lead through to April 2008 when cocoa/plantain took the lead to September 2008. There was significance difference ($P < 0.05$) between them and cocoa sole and cocoa/rice/plantain intercrop. Between September 2007 and January 2008, cocoa/rice/plantain was lower in plant height than cocoa sole without any significance different between them. This might have been due to competition for light on the surface in the intercrop other than the sole crop without any competition for solar energy which was in consonant with finding of [4] that report competition for light in coffee intercropped with maize and cassava.

Table 2 showed the result of plant girth. Cocoa/rice/plantain intercrop gave the least between Sept. 07 and Jan. 08. The highest was in cocoa/plantain followed by cocoa/rice. There was significance difference ($P < 0.05$) between them and cocoa sole and cocoa/rice/plantain.

The leaf area was shown in Table 3. Cocoa/plantain intercrop was significantly higher ($P < 0.05$) than other treatments as from February 2008. It was closely followed by cocoa/rice with effect from April of the same year. There was no significance difference between cocoa sole and cocoa/rice/plantain intercropped.

Table 1 Mean Plant height (cm) of intercropped cocoa with rice and plantain in months after transplanting (Sept. 2007-Sept. 2008).

Treatment	S	O	N	D	J	F	M	A	M	J	J	A	S
Cocoa sole	42.4	46.1	50.6	58.7	59.1	60.0	61.3	62.3	63.3	64.1	68.0	69.2	71.3
Cocoa/rice	41.6	45.9	52.1	60.9	63.8	64.0	65.4	66.8	67.4	70.8	71.2	72.0	74.4
Cocoa/plantain	46.9	51.5	52.8	58.2	58.9	60.1	61.9	65.9	69.6	71.3	72.5	74.8	78.8
Cocoa /rice/plantain	41.5	44.7	55.7	57.8	58.4	61.8	61.7	62.2	64.1	66.2	67.4	68.5	70.1
Mean	43.1	47.1	52.8	58.9	60.0	61.5	62.6	64.3	66.1	67.1	69.8	70.7	73.7
LSD ($P = 0.05$)	3.53	4.18	2.95	1.91	3.49	2.58	2.62	3.30	0.79	6.48	3.39	4.72	5.31

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Table 2 Mean plant girth (cm) of intercropped cocoa with rice and plantain in months after transplanting (Sept. 2007-Sept. 2008).

Treatment	S	O	N	D	J	F	M	A	M	J	J	A	S
Cocoa sole	0.05	0.07	0.09	0.10	0.11	0.10	0.11	0.15	0.17	0.19	0.25	0.30	0.35
Cocoa/rice	0.04	0.06	0.08	0.09	0.10	0.10	0.11	0.14	0.17	0.20	0.27	0.32	0.38
Cocoa/plantain	0.03	0.05	0.09	0.10	0.11	0.12	0.13	0.15	0.17	0.22	0.30	0.37	0.45
Cocoa/rice/plantain	0.04	0.06	0.07	0.08	0.09	0.11	0.11	0.13	0.15	0.18	0.23	0.29	0.23
Mean	0.04	0.06	0.08	0.09	0.1	0.11	0.12	0.14	0.17	0.20	0.26	0.32	0.38
LSD ($P = 0.05$)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.05	0.07

Table 3 Mean leaf area (cm²) of intercropped cocoa with rice and plantain in month after transplanting (Sept. 2007-Sept. 2008).

Treatment	S	O	N	D	J	F	M	A	M	J	J	A	S
Cocoa sole	102.2	107.8	106.1	110.2	110.4	111.3	111.5	114.6	120.0	122.5	127.4	128.1	135.3
Cocoa/rice	101.5	104.2	107.8	111.2	112.9	113.0	113.6	124.0	128.0	131.0	134.0	135.8	139.7
Cocoa/plantain	105.0	109.9	112.0	115.3	118.5	120.7	121.3	130.1	135.0	142.9	145.1	147.0	152.3
Cocoa/rice/plantain	103.7	110.3	113.4	113.7	114.4	115.0	117.1	119.5	123.0	128.3	129.9	131.8	133.4
Mean	103.1	107.8	110.7	112.6	114.4	115.1	116.0	123.8	129.3	132.7	135.0	137.0	140.7
LSD ($P = 0.05$)	2.13	3.98	3.47	3.30	4.08	5.43	5.68	6.36	6.72	9.05	9.58	9.46	1.11

The good growth performance in cocoa/plantain and cocoa/rice intercrops than cocoa sole indicated no deleterious effects of intercropping rice and plantain separately with cocoa at this early stage of growth. This agreed with earlier work on beneficial effect of successfully intercropping with cocoa, oil palm, kola and coffee [2, 3, 5]. It was also in consonant with the work [7] where rice was grown as cover crop with young cocoa, coffee, citrus and rubber in Japan, Brazil, Ivory Coast and Thailand.

Broadleaf weeds were the major weeds found in the experimental site followed by grasses and sedge been the least (Table 4). This confirmed earlier work that reported broadleaf weeds as major weeds found in cocoa farms in Nigeria [8]. Fig. 1 showed the weed biomass from the trial. Cocoa/rice/plantain gave the least weed biomass closely followed by cocoa/plantain and cocoa/rice. The highest weed biomass was from cocoa sole. The shade and the space occupied by the plantain and rice might have contributed to this as it agrees with earlier work on importance of shade for coffee at earlier stage of field establishment [4, 5].

The yield of accompanying crops intercropped with cocoa was shown in Table 5. Yields obtained from the intercrops compare favourable well to their sole in both the rice and plantain. There was no significance

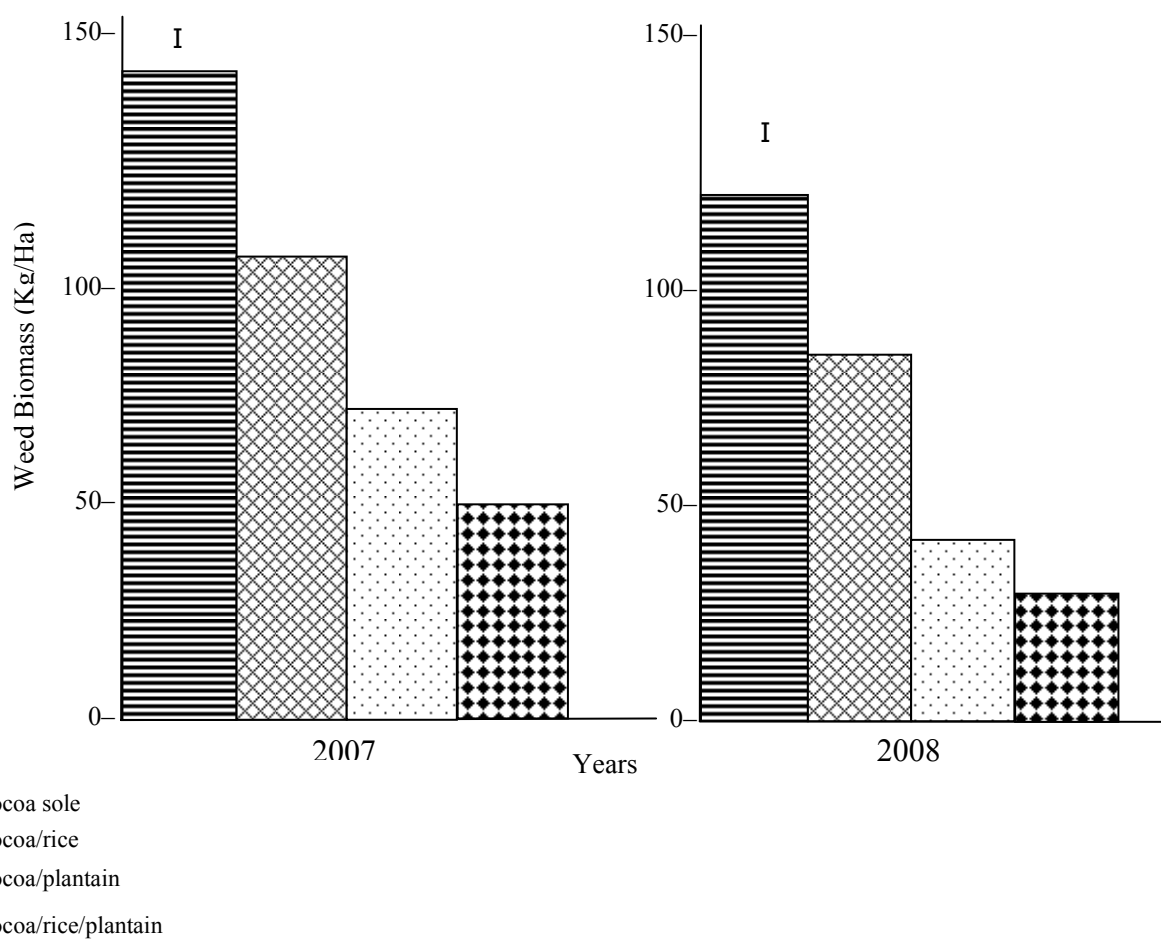
difference between the sole and the intercrops.





The weed biomass obtained from the trial was shown in Fig. 1. The highest weed biomass was obtained from cocoa sole. The least biomass was obtained in cocoa/rice/plantain intercrop.

Table 4 Common weed species at the experimental site.

Weed species		2007	2008
Broad leaves	Family		
<i>Chromolaena odorata</i> (L.)	Compositae	+++	++
R.M. king and Robinson			
<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	+++	++
<i>Talinum triangulare</i> (Jacq) Wild	Portulacaceae	++	+
<i>Ageratum conyzoides</i> L.	Asteraceae	++	+
<i>Euphorbia hirta</i> L.	Euphorbiaceae	+	+
<i>Aspilla africana</i> (Pers.) C.D	Asteraceae	+	+
Adams			
<i>Bidens pilosa</i> Linn.	Asteraceae	+	+
<i>Amaranthus spinosus</i> L.	Amaranthaceae	+	+
Grasses			
<i>Eleusine indica</i> Geartn	Poaceae	+	+
<i>Imperata cylindrica</i> (L.)	Poaceae	+	+
Raeuschel			
<i>Cynodon dactylon</i> (L.)	Poaceae	+	+
Pers			
<i>Paspalum scrobiculatum</i> Linn.			
<i>Panicum maximum</i> Jacq.	Poaceae	+	+
Sedges			
<i>Cyperus rotundus</i> L.	Cyperaceae	+	+
<i>Maricus alternifolius</i> Vahl	Cyperaceae	+	+

+++ High infestation (60-90% occurrence); ++ Moderate infestation (40-59% occurrence); + Low infestation (1-39% occurrence).



 Cocoa sole
 Cocoa/rice
 Cocoa/plantain
 Cocoa/rice/plantain

I LSD ($P < 0.05$)

Fig. 1 Effect of intercropping on weed biomass of cocoa in Uhonmora, Nigeria.

Table 5 Average yield of rice and plantain in t/ha on intercrops with cocoa at Uhonmora.

Treatment	Yield T/HA	
	Grain	Bunch
Sole rice	2.1	-
Sole plantain	-	61.3
Cocoa/Rice	2.0	-
Cocoa/Plantain	-	61.2
Cocoa/rice/Plantain	1.9	61.1
Mean	2.0	61.2

Cocoa/plantain and cocoa/rice were lower in weed biomass than cocoa sole. The shade and space occupied by plantain and rice might have contributed to the reduction in weed biomass. This was in consonant with earlier work where plantain was used as shade crop for coffee at early stage of field establishment [4, 5].

4. Conclusion

Though the result showed that cocoa/rice/plantain has the least weed biomass but its cocoa seedlings were not as vigorous morphologically as those in cocoa/plantain and cocoa/rice/plantain. The reduction in plant vigour observed in cocoa/rice/plantain might have been due to underground and aerial competition for soil nutrients and sunlight by the associated crops. The average yield of the associated crops confirms that intercropping of cocoa with rice and plantain did not only reduced weeds but also give additional yield increase (food production) while the yield from the main crop is being awaited.

Therefore, cocoa/plantain and cocoa/rice intercrops which are of good plant growth with lower weed

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biomass could be recommended to cocoa farmers in Nigeria instead of sole planting at early stage of field establishment.

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