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STUDIES ON BANANA INTERCROPPING WITH DIFFERENT FOOD AND VEGETABLE CROPS IN THE WINDWARD ISLANDS[1]

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SUMMARY

Two banana intercropping experiments, involving dasheen, cowpea, sweetpotato and groundnut were initiated during the rainy season on farmers' holdings in St. Lucia and St. Vincent. The farmer's existing intercropping practice at each location was included as one of the treatments. In both experiments, the intercrops did not significantly influence the yield and yield components of banana on a system-basis. However, except in Experiment 1, the treatments significantly delayed the production cycle of banana, and the pattern and the extent of delay continued into the first ratoon. Intercropping affected the concentration of nutrients in the banana leaves and some chemical properties of the soil. In general, interplanting resulted in greater cash returns per unit area.

INTRODUCTION

In traditional agriculture of the tropics or subtropics, mixed cropping as opposed to pure stand cropping is usually the dominant practice. More recently intercropping, that is growing two or more crops in different but proximate rows on the same field, has been practiced in some areas. Even though the practice of mixed cropping is centuries old, the modern concepts of intercropping are relatively new.

Banana is the most important economic crop in the Windward Islands. Both sole cropping and intercropping of banana are common. Food and vegetable crops observed in combination with banana and plantain include maize and bean (Malima, 1976), cocoyam (Fongyen, 1976, Henderson and Gomes, 1979, and Karikari, 1972), sweetpotato, dasheen and cucumber (Henderson and Gomes, 1979). The main reasons for intercropping of banana with food crops are: to offset some of the overhead costs of plantation establishment (Fongyen, 1976), to have extra food or cash return (Ruthenberg, 1976) and to suppress weed growth (Fongyen, 1976).

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Interplanting of banana with cowpea, maize and sweetpotato delayed the production cycle slightly but had no adverse effect on yield (Seeyave and Baynes, 1974). Devos and Wilson (1978) reported that intercropping of plantain with cocoyam did not reduce the plantain yield or delay harvest. However, in another study it was observed that the associated growth of maize and cassava with plantain extended days to harvest significantly with no reduction in the yield (Devos and Wilson, 1979). WINBAN initiated a systematic research in 1978 in the Windward Islands to study the effect of intercropping of banana and plantain with a range of food and vegetable crops on (a) the agronomic productivity and (b) the economic profitability of various cropping systems under different agroecological and edaphic conditions. The experiments reported on herein form a part of the on-going Cropping Systems Research Project at WINBAN.

MATERIALS AND METHODS

Experiment 1:

The experiment was conducted on a farmer's holding at Fond Assau, St. Lucia, on a clay loam with a pH of 4.9, Truog P: 5.7 ppm, and exchangeable cations (meq/100g of soil) K: 0.92, Ca: 8.47 and Mg: 8.97. The experimental site is located at an elevation of 90 m above sea level and receives an annual rainfall of about 2.25 m. The land was prepared by ploughing and levelling. Uniform sword suckers of the banana (cv Valery) were planted at a spacing of 2.13 x 2.13 m on 1st. July, 1980. The plant crop received 228 g/mat of 16:4:24 NPK mixed fertilizer and the first ratoon was supplied with 342 g/plant of 16:8:24+2 NPK + MgO mixed fertilizer. At planting, Furadan (nematicide) was applied at 10g/planting hole. The layout was a randomized block design with four replicates of 15 plants per plot.

The treatments were:

1. Banana + 2 rows Dasheen (B + 2D) (Farmer's practice)
2. Banana + 3 rows Dasheen (B + 3D)
3. Banana + 4 rows Cowpeas (B + 4C)
4. Banana + 3 rows Dasheen + 4 rows Cowpeas (B + 3D + 4C)

The intercrops were planted between banana rows on 21st August 1980. Dasheen in treatments 2 and 4 was fertilized with 75 Kg N, 60 Kg P_2O_5 and 180 Kg K_2O per hectare at the time of planting. The intercrop details are presented in Table 1.

Experiment 2:

This experiment was laid out at Orange Hill Estate, St. Vincent, on a Sandy loam with a pH of 5.6, Truog P: 72 ppm, and exchangeable cations (meq/100 g of soil) K: 0.70, Ca: 2.52 and Mg: 0.75. The experimental site is situated at about sea level and receives an annual

Table 1.--Particulars of Intercrops

Intercrop	Variety	Spacing	Date of harvest	Duration
		cm		days
Cowpea	Cal. Blackeye No. 5	50 x 20	19.11.80	90
Dasheen	Local	60 x 60 (T1)	31.3.81	223
		50 x 50 (T2&T4)	"	"

rainfall of about 2.33 m. The field was ploughed and levelled. Uniform corms of the banana (cv Valery) were planted on 6th June 1980 in holes of 0.3 m depth at 2.44 x 2.44 m. Each banana stem received 0.34 kg of 16:4:24 NPK fertilizer every three months. The experimental layout was a randomized block design with four replicates of 18 plants per plot. The treatments were:

1. Sole banana (b) (Farmer's practice)
2. Banana + 4 rows Cowpeas (B + 4C)
3. Banana + 6 rows Groundnuts (B + 6G)
4. Banana + 4 rows Sweetpotato (B + 4S)

The intercrops were planted on 24th July 1980 and did not receive any fertilizer. The intercrop details are presented in Table 2.

Table 2.--Particulars of Intercrops

Intercrop	Variety	Spacing	Date of harvest	Duration
		cm		days
Cowpea	Cal. Blackeye No. 5	50 x 20	23.10.80	84
Groundnut	Spanhoma	30 x 10	20.11.80	120
Sweetpotato	Local	50 x 50	9.2.81	201

The circumference of the pseudostem at 15 cm above ground level was recorded twice in the plant crop. The yield and yield attributes were collected on all plants and the marketable yield was computed after excluding the stalk weight. Soil and banana leaf samples were collected to determine the changes, if any, in nutrient status.

RESULTS AND DISCUSSION

In Experiment 1, cowpea was established in two cropping systems simultaneously and at similar plant population. In one treatment, banana + 4 rows cowpea (B + 4C), the intercrop was not fertilized whereas in the other treatment, banana + 3 rows dasheen + 4 rows cowpea (B + 3D + 4C) the legume was grown in association with dasheen which was fertilized with 75 kg N, 60 kg P_2O_5 and 180 kg K_2O per ha by broadcasting at the time of planting. A slightly greater seed yield was recorded in cowpea grown in B + 3D + 4C than in B + 4C, however, the difference was not statistically significant (Table 3).

Table 3.--Yield of intercrops in various cropping systems

Treatments	Yield (Kg/ha)			
	Cowpea	Groundnut	Sweetpotato	Dasheen
Experiment 1				
B + 2D	-	-	-	2052
B + 3D	-	-	-	3137
B + 4C	698	-	-	-
B + 3D + 4C	762	-	-	3644
LSD (P=0.05)	NS	-	-	NS
Experiment 2				
B	-	-	-	-
B + 4C	0	-	-	-
B + 6G	-	580	-	-
B + 4S	-	-	493	-

Dasheen was included in three treatments with varying plant population, fertilizer regime and crop association. The application of fertilizer and increase in the density of dasheen increased the tuber yield by 52 percent in banana + 3 rows dasheen (B + 3D) and by 77 percent in B + 3D + 4C as compared to banana + 2 rows dasheen (B + 2D), however, the differences in tuber yield were non-significant owing to greater

coefficient of variation (28.0%) (Table 3). In this study, the effects of increase in population and fertilizer application cannot be isolated. Therefore, it is not known whether the increase is due to one factor or both. The association of cowpea had an additive effect on dasheen yield.

In Experiment 2, cowpea failed to produce any seed (Table 3). There were no pods even though vegetative growth was good. The lack of pod formation may possibly due to a hot spell with a temperature of about 33°C followed by sudden rains at the time of formation of floral primordia.

The pod yield from groundnut was normal; whereas the tuber yield from sweetpotato was quite low. According to Badillo-Feliciano and Lugo-López (1977) and Gollifer (1980) sweetpotato yields better when planted between September and February. In this present study it was, however, planted in July in keeping with the farmer's existing practice (Henderson and Gomes, 1979). Though the intercrop had a good vine growth and the crop was in the field for a longer duration (201 days) the tuber yield was low.

The cropping systems did not influence of the girth of the banana pseudostem significantly except at four months after planting in Experiment 1 (Table 4). This time, bananas associated with cowpea (B + 4C)

Table 4.--Effect of cropping systems on the circumference of pseudostem

Treatments	Girth (cm) of pseudostem (months after planting)	
Experiment 1	4	9
B + 2D	34.5	63.5
B + 3D	38.1	67.7
B + 4C	25.5	64.0
B + 3D + 4C	31.7	66.0
LSD (P=0.05)	6.6	NS
Experiment 2	4	8
B	42.8	55.9
B + 4C	38.1	54.9
B + 6G	40.1	54.7
B + 4S	38.4	52.4
LSD (P=0.05)	NS	NS

recorded the lowest circumference (25.5 cm) which was at par with those in B + 3D + 4C (31.7 cm). The bananas in the latter treatment did not differ significantly with those in B + 2D and B + 3D. With time, the variations in the size of the pseudostem tended to narrow down and by 9 months the differences in the girth of the pseudostem were non-significant.

Except in the first ratoon in Experiment 1, the intercrops significantly influenced both days to shooting and harvesting of bananas (Table 5). In Experiment 1, the bananas in B + 4C took a greater number

Table 5.--Effect of cropping systems on the production cycle of bananas

Treatments	Days taken from planting to shooting	Days taken from planting to harvesting
Experiment 1	Plant Crop	
B + 2D	217	309
B + 3D	215	301
B + 4C	254	344
B + 3D + 4C	236	328
LSD (P=0.05)	21.2	20.8
	First Ratoon	
B + 2D	488	587
B + 3D	497	598
B + 4C	513	606
B + 3D + 4C	504	601
LSD (P=0.05)	NS	NS
Experiment 2	Plant Crop	
B	188	266
B + 4C	200	278
B + 6G	214	294
B + 4S	229	306
LSD (P=0.05)	22.5	18.4
	First Ratoon	
B	376	457
B + 4C	391	474
B + 6G	396	480
B + 4S	415	500
LSD (P=0.05)	13.1	10.7

of days both up to shooting and harvesting in the plant crop as well as in the first ratoon. In the plant crop, the differences in the number of days to shooting among B + 2D, B + 3D and B + 3D + 4C were non-significant; however, the bananas in the latter treatment recorded significantly more days to harvesting as compared to B + 3D. The intercropping of banana with cowpea (B + 4C) had a greater adverse effect on the production cycle than other crop-associations. This finding is contrary to earlier results when intercropped cowpea, had the least adverse effect on both the days to shooting and to harvesting of banana (Rao and Edmunds 1981a and Rao and Edmunds 1981b). Little or no delay in the production cycle of banana, is expected as a result of intercropping with cowpea due to (a) the shorter duration and (b) low growing habit of this crop. In the present investigation, the greater delay in the production cycle of banana was mainly due to more "supplies" in cowpea plots owing to poor drainage. However, in the first ratoon, the effect of intercrops on the production cycle of banana was much less as compared to the plant crop.

In Experiment 2, the pattern of delay in days to shooting and harvesting was similar both in the plant crop and the first ratoon. Sole bananas took the shortest period for completion of production cycle of both plant crop (266 days) and the first ratoon (457 days). Intercropping of banana with sweetpotato extended the production cycle considerably more than did other crops. The greater adverse effect of sweetpotato on the production cycle may be due to a longer field occupation period (201 days). The low growing legumes (cowpea and groundnut) had a lesser effect on the production cycle due to their comparatively shorter duration. The extent and the pattern of delay on the production cycle continued even into the first ratoon, perhaps due to lack of fertilizer application to the intercrops. A significant delay in the production cycle of banana as a result of intercropping with maize and sweetpotato was observed by Seeyave and Baynes (1974) and similar findings in plantain with maize and cassava were reported by Devos and Wilson (1979).

On a system-basis, intercropping of banana with various food and vegetable crops did not influence the yield and yield attributes significantly (Table 6). This is consistent with the findings of Seeyave and Baynes (1974), Devos and Wilson (1978) and Devos and Wilson (1979). In Experiment 1, the farmers' practice (B + 2D) yielded the lowest both in the plant crop and in the first ratoon; however, in Experiment 2, sole bananas yielded slightly higher than the other systems. The total banana yield (plant crop + first ratoon) varied from 106.2% to 108.2% relative to B + 2D in Experiment 1 and it fluctuated from 92.0% to 99.1% relative to sole bananas in Experiment 2 (Table 7).

In Experiment 2, the treatments did not influence the concentrations of N, Mg and Mn in the leaf significantly (Table 8). The percent P and K contents in banana leaves intercropped with sweetpotato were significantly higher than that in other systems. The banana in pure stand registered the lowest P and K contents. A reverse trend in the

concentration (%) of Ca was observed with intercropping, that is, the banana interplanted with the tuber crop recorded significantly lowest Ca content (0.68%) whereas the sole bananas had the highest (0.87%). The significantly lower concentration (%) of P and K in sole bananas and those intercropped with cowpea and groundnut than those interplanted with sweetpotato may be due firstly to the early translocation of these nutrients from the "Source" to the "sink" owing to early floral initiation as evidenced by less number of days to shooting (Table 5) and secondly to the "dilution effect" as indicated by the bigger plant size (Table 4).

Table 6.--Yield and yield components of banana as affected by intercropping

Treatments	Yield	Average bunch wt.	Average No. of hands/ bunch	Average No. of fingers/ bunch	Average hand wt.	Average finger wt.
	T/ha	Kg			Kg	G
Experiment 1			Plant Crop			
B + 2D	38.92	17.66	6.8	104	2.56	171
B + 3D	42.60	19.33	7.2	113	2.68	170
B + 4C	42.73	19.39	7.1	110	2.70	176
B + 3D + 4C	40.18	18.24	7.1	110	2.55	166
LSD (P=0.05)	NS	NS	NS	5	NS	NS
			First Ratoon			
B + 2D	46.29	20.99	7.8	123	2.61	169
B + 3D	47.91	21.74	8.0	125	2.67	171
B + 4C	49.48	22.45	8.1	130	2.73	170
B + 3D + 4C	51.25	23.27	8.4	131	2.78	173
LSD (P=0.05)	NS	NS	NS	NS	NS	NS
Experiment 2			Plant Crop			
B	25.52	15.19	6.5	90	2.32	168
B + 4C	25.05	15.12	6.4	87	2.38	174
B + 6G	25.45	15.15	6.3	85	2.32	173
B + 4S	22.02	13.11	5.9	76	2.17	175
LSD (P=0.05)	NS	NS	NS	NS	NS	NS
			First Ratoon			
B	32.89	21.68	7.6	118	2.56	166
B + 4C	32.81	22.12	7.7	119	2.55	164
B + 6G	31.61	22.13	7.7	124	2.54	170
B + 4S	31.71	22.54	7.9	125	2.56	162
LSD (P=0.05)	NS	NS	NS	NS	NS	NS

Table 7.--Total banana yield (plant crop + first ratoon) as influenced by cropping systems

Treatments	Yield	Percent relative to farmers' practice
	(T/ha)	
Experiment 1		
B + 2D	85.20	-
B + 3D	90.51	106.2
B + 4C	92.21	108.2
B + 3D + 4C	91.46	107.3
LSD (P=0.05)	NS	-
Experiment 2		
B	58.41	-
B + 4C	57.85	99.1
B + 6G	57.06	97.7
B + 4S	53.72	92.0
LSD (P=0.05)	NS	-

The lower Ca content in banana leaves associated with sweetpotatoes was probably due to greater requirement for that nutrient by the intercrop thereby causing severe competition with the main crop.

Table 8.--Effect of intercropping on nutrient concentrations in banana leaves: Experiment 2

Treatments	Percent					Ppm
	N	P	K	Ca	Mg	Mn
B	3.27	0.195	2.87	0.87	0.348	202
B + 4C	3.29	0.205	3.08	0.81	0.349	200
B + 6G	3.22	0.196	3.03	0.81	0.307	186
B + 4S	3.04	0.221	3.35	0.68	0.330	145
LSD (P=0.05)	NS	0.009	0.23	0.12	NS	NS

In Experiment 2, cropping systems influenced pH, Truog P and exchangeable Ca content of the soil significantly (Table 9). Both

soil pH and exchangeable Ca were significantly lower in banana + sweetpotato as compared to the rest.

Table 9.--Effect of intercropping on some chemical properties of soil Experiment 2

Treatments	pH	E.C. (μmhos)	Total Organic N (μg/g)	Truog P (ppm)	Exch. Cations (m.e./100g)			Exch. Mn (ppm)
					K	Ca	Mg	
B	5.0	335	0.57	69	0.78	2.93	0.64	4.5
B + 4C	4.9	315	0.66	52	0.91	2.79	0.68	4.3
B + 6G	5.0	326	0.59	59	0.87	2.67	0.65	4.4
B + 4S	4.6	530	0.54	74	1.13	1.49	0.60	5.3
LSD (P=0.05)	0.2	NS	NS	5	NS	0.62	NS	NS

The differences in these two properties among sole banana and banana intercropped with cowpea and groundnut were non-significant. The Ca requirement of sweetpotato was greater and it was in the field for a longer period (201 days) as compared to other intercrops. Consequently, the available Ca content in the soil solution has dropped significantly. Possibly due to removal of much of divalent cations (Ca^{2+}), the soil pH in sweetpotato plots was lowered considerably (Mengel and Kirby, 1978). Total soil organic N contents were better with cowpea and groundnut probably due to the fixation of atmospheric N by symbiotic bacteria associated with these legumes.

In Experiment 1, the cumulative net revenue (plant crop + first ratoon) was 6.2%, 27.0% and 13.0% higher in B + 3D, B + 4C and B + 3D + 4C, respectively, than in B + 2D (Table 10). The total net revenue in cowpea-based cropping patterns was considerably higher than in dasheen-based cropping systems due to the lower cost of production. However, in Experiment 2, the cumulative net revenue in sole banana was slightly higher than the rest due to failure and/or poor performance of intercrops.

Table 10.--Total revenue (EC$ per ha) as influenced by cropping systems

Treatments	Gross revenue	Cost of production	Net revenue	Gross revenue	Cost of production	Net revenue	Total
Experiment 1		Plant Crop			First Ratoon		
B + 2D	17,848	10,765	7,083	19,349	2,468	16,881	23,964
B + 3D	20,221	12,331	7,910	20,026	2,468	17,558	25,468
B + 4C	19,848	7,661	12,237	20,682	2,468	18,214	30,451
B + 3D + 4C	21,780	13,643	8,137	21,422	2,468	18,954	27,091
Experiment 2		Plant Crop			First Ratoon		
B	8,930	5,185	3,745	11,511	3,135	8,375	12,120
B + 4C	8,767	5,806	2,961	11,483	3,135	8,348	11,309
B + 6G	10,567	6,433	4,134	11,063	3,135	7,928	12,062
B + 4S	7,963	5,823	2,140	11,098	3,135	7,963	10,103

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