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EVALUATION OF SEQUENTIAL AND MIXED ROW INTERCROPPING IN CASSAVA

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One of the methods suggested for improving the productivity of cassava-based cropping systems is to adopt multiple cropping practices like intercropping/ mixed cropping, the advantages of which are discussed in detail by Andrews and Kassam (1976). A wide variety of crops like cereals, legumes, vegetables, medicinal plants, oil seeds etc., are reported to be in use as intercrops in cassava. Paired row planting of cassava has been suggested both under sole and intercropped situations (Fzumah and Okigbo, 1980). Paired row-planted cassava offers opportunity for growing short duration intercrops in sequence or mixed row intercropping with short and long duration crops. The concept, though found unsuccessful under normal planting of cassava (AICPITC, 1978 and CTCRI, 1978) has not been tested under paired row planting wherein we except free interspace for prolonged periods of time. Hence experiments were undertaken to study the possibility of growing short duration intercrops in sequence or short and long duration intercrops in mixed row.

Materials and Methods

Experiments were conducted at the College of Horticulture, Kerala Agricultural University, Trichur, Kerala, to study the possibility of sequential intercropping of cassava planted in paired row (90×50—130 cm) with groundnut (*Arachis hypogaea* L.) of cowpea (*Vigna unguiculata* (L.) Walp) and the mixed row intercropping with groundnut and redgram (*Cajanus cajan* (L.) Millsp). The sequential intercropping practices studied were cassava+cowpea (khariff)—cowpea (rabi), cassava+cowpea (khariff)—groundnut (rabi), cassava+groundnut (khariff)—groundnut (rabi) and cassava+groundnut (khariff)—cowpea (rabi). In all the sequential intercropping treatments four rows of the intercrops were sown in the interpair spaces.

The mixed row intercropping practice evaluated was sowing of four rows of groundnut and one row of redgram in interpair space of cassava. The spacing for groundnut/cowpea was 30×20 cm and for redgram 45 cm between plants within the row. The cassava and the khariff intercrops were planted on the same day in May. The experiment was conducted for two seasons during 1984 and 1985.

Besides the treatments mentioned above, cassava in normal spacing (90x90 cm)+groundnut, cassava in normal spacing + cowpea, paired row planting of sole cassava at a spacing of 50x90 cm within the pair and 130 cm between pairs and sole crop of cassava in normal spacing were included in the experiment as controls. The experiments were laid out in randomised block design and

replicated thrice in plots of size 5.4x5.4 m. The varieties used for the trials were M4, a non-branching popular type of cassava; TMV2, a bunch type of groundnut; C152, a bush type of short duration cowpea and a local type of long duration redgram. The cultural and manurial practices recommended for cassava and the intercrops were followed (KAU, 1982). The cowpea and the groundnut were harvested 90 and 120 days after planting respectively. The red gram was harvested 120 days and cassava 270 days after planting.

Results and Discussion

Height and leaf area of cassava

The height of cassava in paired row in general was not influenced by the cropping systems. Eventhough the control vs. rest comparisons were significant at some of the stages of growth, no specific trend could be observed. In the cropping system, cassava + groundnut + redgram the cassava plants were taller at later stages of growth. The intercrops cowpea and groundnut were short statured and of short duration. They were harvested by the time the cassava canopy was fully developed. Hence, cowpea and groundnut did not show much influence on cassava height. In the case of cassava + groundnut + redgram cropping system the redgram also was competitively elongating along with cassava during the later stages. Probably to avoid competition cassava tried to outgrow redgram resulting in taller plants in that treatment.

The leaf area of cassava in general, was not significantly influenced by the cropping system. At some stages though it was significant no definite trend could be obtained. Comparisons between the control and other treatments were not significant.

Number, length and girth of tuber

The number of tubers per plant (Table 1) was not significantly influenced by cropping systems. The control vs. rest of the treatments were on par. The length of tuber also showed similar results. The cropping systems had no significant effect on girth of tuber (Table 1). The tuber number is decided during the early stage itself (Hunt *et al.*, 1977); it takes some time for the cassava plants on the ridges to send out roots into the rhizosphere of the intercrops. Hence the fertilizers applied to the intercrops were not available to cassava during the early stage resulting in more or less uniform number of tubers in all the plots.

Yield of tuber

The tuber yield (Table 1) was not significantly influenced by the cropping systems. Experiments conducted at the College of Agriculture, Vellayani, Kerala also showed that cassava yield was not affected by growing grountnut as intercrop in cassava (Sheela, 1981). Contrary to this, Anilkumar (1984) from the same station recorded a lower yield of cassava both in paired and normal methods of

planting when intercropped with cowpea or groundnut. He had found that the yield depression was more with cowpea as intercrop. One of the reasons for the varying results obtained in the present study may be that the cowpea cv. C152 used here is comparatively nonspreading as compared to the cv. *Kanakamani* used by Anilkumar (1984). Bridgit (1985) observed an increase in tuber yield of cassava when intercropped with groundnut. The tuber yields in control plots were on par with other treatments. Cassava yield in the cropping system cassava + groundnut + redgram was also on par with the sole cassava.

These results show that either in the paired row or in the normal method of planting cassava, legume intercrops do not in any way reduce the yield of cassava. This is very much apparent in cassava + groundnut + redgram where in spite of the simultaneous presence of two intercrops the tuber yield remained on par with the sole cassava. Since cassava was planted in paired row, the interspaces avaibable were more. The initial growth rate of redgram was low and so its canopy was always below that of cassava during the early phases. This low pace of growth continued till the groundnut crop was harvested. After this there was a sharp increase in the growth rate of redgram and it increased in height and leaf area substantially. By the time of harvest of cassava, the redgram plants were almost as tall as cassava. Still it did not offer much competition to cassava since cassava had a less vigorous rate of growth during the later stages on account of then prevailing dry season. It may also be noted that both the intercrops were legumes. The root systems of these legumes were confined to a smaller soil volume. Hence the competition for plant nutrients will be mild and one can expect the benefit of N fixation also. Hence it was possible to obtain full yield of cassava even after growing two intercrops *viz.,* groundnut and redgram, the former being of short duration and short stature and latter being of long duration and tall growth. Mattos *et al.* (1980) reported that in paired row planting of cassava, there was not much scope for competition from the intercrops grown in the interrow spaces.

Intercrop

The second saason (rabi) intercrop of cowpea of groundnut raised in sequence to the first season (kharif) cowpea or groundnut was unsucessful in cassava since the interspaces were completely shaded by the tall growing cassava. Another probable limiting factor is the soil moisture at the time of sowing of the second season intercrops. Hence, the data on the second season intercrops are not presented and discussed.

Cowpea

The intercrop cowpea in paired row and normal planted cassava gave almost similar yields.

The sole cowpea produced higher yield during both the years on per hectare basis and not on per plant basis (Table 2) indicating that the yield of cowpea was not reduced on account of the competition from cassava. The yield reduction observed

in intercrop cowpea on per hectare basis is mainly due to the population difference in sole and intercropped situations. The sole crop had a population of 1.67 lakhs whereas the intercrop had only 1.11 lakhs per hectare.

The fresh weight of haulm per plant (Table 2) showed a significant increase in the intercropped situation as compared to the sole crop. Similar increase in vegetative growth of cowpea when grown as intercrop or put under shade was reported by Sheela (1981), George (1982) and Anilkumar (1984).

Groundnut

The sole groundnut gave higher yield than the intercrop (Table 2) on per hectare basis but on per plant basis it was on par. The groundnut pod yields in cassava + groundnut + redgram and cassava + groundnut cropping systems were on par.

The higher per hectare yield worked out for sole groundnut is mainly due to the population effect. This is evident from the per plant yield which dose not vary remarkably in sole and intercrop groundnut. The yields of groundnut intercropped in normal and paired row planted cassava were on par. Such observation was made by Anilkumar (1984) also.

Table 1

Effects of sequential intercropping with legumes on number, length, girth and yield of cassava in paired row

Cropping systems	(.1983-84)				(1984—85)			
	No. of tubers	Tuber length (cm)	Tuber girth (cm)	Tuber yield (t/ha)	No. of tubers	Tuber length (cm)	Tuber girth (cm)	Tuber yield (t/ha)
C+CP—CP	6.6	38.2	16.5	15.78	8.7	39.0	17.2	19.10
C+CP—GN	7.4	38.5	16.3	17.42	9.7	38 5	17.5	18.25
C+GN—CP	6.6	36.8	16.7	17.50	9.6	37.8	18.0	19.81
C+GN—GN	7.9	37.5	16.2	15.97	8.9	392	17.2	18.21
C+GN—RG	—	—	—	—	9.5	88.4	17.3	19.51
Controls								
C(N)+GN	7.3	37.5	16.0	18.52	10.0	38.8	17.4	19.62
C (N)+CP	7.3	38.4	16.5	18.11	9.7	38.2	17.5	19.75
C	7.7	38.6	16.2	17.35	8.0	39.2	17.5	20.20
C (N)	7.7	38.0	16.3	16.88	10.0	38.5	17.7	20.51
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
SEM ± .	0.5	0.7	0.2	0.99	0.4	0.6	0.3	0.90

C = cassava in paired row, C (N) = cassava in normal planting,
CP = cowpea, GN = groundnut. RG = redgram

The fresh haulm weight of groundnut (Table 2) was lower in the sole crop as compared to that in intercrop. In cassava + groundnut + redgram intercropping also groundnut haulm weight was higher than that in sole crop.

Redgram

The redgram yield (Table 2) was low in the intercropped plots compared to the sole crop. This was true when yield per plant or yield per hectare was compared. The yield per plant was reduced by 37 per cent and on per hectare basis the reduction was 80 per cent.

The reduction in per plant yield may be due to the competition for aerial space between cassava and redgram. From a shade tolerance study, George (1982) observed that redgram was shade sensitive and under extremely shaded situations even pod formation was retarded. The large reduction of grain yield observed in the intercrop redgram on per hectare basis is attributed to the reduced plant population in this situation. The population of intercrop redgram was only about 33 per cent of the sole crop.

The haulm weight (Table 2) showed a reverse trend as compared to grain yield. It was more in intercrop redgram on per plant basis. The taller growth and higher leaf area of intercrop redgram resulted in more haulm weight. The increased haulm weight on per hectare basis observed in sole redgram is only the effect of higher population.

Table 2

Yield and haulm weight of intercrop cowpea, groundnut and redgram

	(1983-84)			(1984—85)		
	Grain yield		Haulm weight	Grain yield		Haulm weight
	kg/ha	g/plant	g/plant	kg/ha	g/plant	g/plant
			COWPEA			
C+CP	634	6.2.	89.5	664	6.0	79.8
Sole CP	1067	6.4	70.6	1078	6.4	71.8
CD (0.05)	96	N. S.	9.2	86	N. S.	N. S.
SEM±	32	0.5	3.0	29	0.4	4.8
			GROUNDNUT			
C+GN	1106	10.0	84	1157	10.4	72
C+GN+RG	—	—	—	1233	11.1	75
Sole GN	1980	11.9	46	1988	11.9	65
CD (0.05)	367	3.3	14	112	1.0	9
SEM±	121	1.1	4.5	37	0.3	3.0
			REDGRAM			
C+GN+RG	—	—	—	222	24	295
Sole RG	—	—	—	1056	38	262

C = paired row cassava, GN = groundnut, RG = Redgram

Land equivalent ratio

The land equivalent ratio (LER) of cassava worked out as suggested by Willey (1979) was not significantly influenced by the intercrop of cowpea or groundnut. The total LER values in all the intercropping systems were superior to sole cropping. The maximum value was recorded by cassava + groundnut + redgram followed by cassava + groundnut and cassava + cowpea intercropping systems. The LER valve of the intercrop redgram was the lowest. It was partly due to the low plant population of intercrop redgram and its shade susceptible nature. It may be seen that on per plant basis also the intercrop redgram yield was considerably lower.

Economics

The abstract of data on the economics of the different intercropping systems showed that the gross and net income were higher by the inclusion of intercrops in cassava. The income was highest in cassava+groundnut + redgram followed by cassava+groundnut and cassava+cowpea, eventhough there was not much difference between the latter two. Sole cassava recorded the lowest return. The LER

Table 3

Effects of sequential intercropping with legumes on the land equivalent ratio of cassava and intercrops

	Land equivalent ratio					
	(1983—84)			(1984—85)		
Cropping systems	Cassava	Intercrops	Total	Cassava	Intercrops	Total
C+CP—CP	0.99	0.53	1.52	0.96	0.60	1.56
C+CP—GN	1.10	0.59	1.69	0.92	0.55	1.47
C + GN—CP	0.99	0.72	1.71	0.92	0.66	1.58
C+GN—GN	1.10	0.65	1.75	0.99	0.59	1.58
C+GN+RG	—	—	—	1.01 (0.30)*	0.58	1.89
Controls						
C (N)+GN	1,13	0.56	1.69	1.00	0.55	1.55
C (N)+CP	1.15	0.90	2.05	0.98	0.70	1.68
C	1.23	—	1.23	1.00	—	1.00
C (N)	1.00	—	1.00	1.00	—	1.00
CD (0.05)	NS	—	0.46	NS	—	0.22
SEM±	0.15	—	0.16	0.08	—	0.01

C = paired row cassava, C (N) - cassava in normal planting
CP = cowpea, GN = groundnut, RG = redgram

* Figure in parenthesis is LER of redgram

values also indicated similar pattern of results. There was a progressive increase in returns with corresponding increase in LER. This shows that the cropping systems adopted are viable and scientific. The canopy architecture of the crops selected as intercrop must have played an important role in establishing the relationship between LER and the net income.

The benefit cost ratio worked out showed that the maximum (1.94) was in the case of cassava + groundnut + redgram. There was not much difference in the benefit cost ratio of the other cropping systems which recorded a value of 1.86 for cassava + groundnut, 8.11 for cassava + cowpea and 1.83 for sole cassava.

So it can be concluded that cassava + groundnut is the best intercropping system whether cassava is planted in paired row or normal method. Cassava + groundnut+redgram is possibly a still superior cropping system, when cassava is planted in paired row.

Summary

The prospectus of sequential intercropping of cassava, planted in paired row with groundnut/cowpea and mixed row intercropping with groundnut + redgram was studied in a field trial. Groundnut and cowpea was successful as a *Kharif* intercrop. The *Rabi* intercrops sown in sequence to *Kharif* intercrop failed to give economic yield. Mixed row intercropping of cassava with groundnut + redgram gave the highest benefit : cost ratio followed by cassava + groundnut. None of the intercrops affected the cassava yield.

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