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Weed management studies in cassava *(Manihot esculenta* L.*)* intercropping systems under irrigated conditions

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ABSTRACT

A field experiment was conducted during 2003-04 and 2004-05 to asses the production potential of intercropping of cassava (*Manihot esculenta* L.) with groundnut (*Arachis hypogea*), vegetable cowpea (*Vigna sinensis*) and black gram (*Vigna mungo*) in relation to various weed control practices. Intercropping influenced the population of grasses, sedges, BLW and total dry matter production of weeds. Weed management caused significant improvement in growth, yield and economic returns of cassava system. Best results were achieved with intercropping of vegetable cowpea with pre-emergence application of fluchloralin 0.75 kg/ha + one hand weeding 4 weeks after planting followed by application of alachlor @ 1.5 kg/ha + one hand weeding 4 weeks after planting.

Key words: Cassava, intercropping, weed control, yield, economics

INTRODUCTION

Cassava cultivation is amenable for growing intercrops as it is a long duration crop. Like many other crops, cassava crop also suffers from competition by weeds for space, light, water and nutrients (Davis and Gardner, 1985). The early stages of growth are normally susceptible for competition by weeds and hence keeping the crops weed free during this phase is the pre-condition for higher productivity. However, control of weeds in intercropping systems through cultural or mechanical methods is difficult due to narrow inter-row spacing. Therefore, the present investigation was undertaken to assess the production potential of intercropping system of cassava with various methods of weed control under rainfed condition.

MATERIAL AND METHODS

A field experiment on cassava intercropping in the garden land conditions was conducted in the month of August during 2003-04 and 2004-05 at Agricultural College and Research Institute, Madurai. The parameters regarding the soil fertility status of the experimental area were recorded. The pH and EC of the soil were 7.4 and 0.42 m mho/cm respectively. The physical parameters including clay– 25.1%, silt -11.5%, fine sand -37.4%, coarse sand-22.8% and bulk density -1.48 g / cc and the chemical characters such as available N – 218.3 kg/ha, available P_2O_5 – 12.74 kg/ha, available K_2O – 271.82 kg /ha and organic carbon – 0.49% were also recorded. The experiment was conducted in split plot design replicated thrice. The treatments consisted of six intercropping systems, groundnut (I_1), vegetable cowpea (I_2), blackgram (I_3), groundnut followed by blackgram (I_4), cowpea followed by blackgram (I_5) and pure crop (I_6) as main plot and six weed control measures *viz.*, pre-emergence application of pendimethalin 0.75 kg/ha + one hand weeding during 4 WAP (W_1), Pre-emergence application of alachlor 1.5 kg/ha + one hand weeding during 4th week after planting (W_2), pre-emergence application of fluchloralin 0.75 kg/ha + one hand weeding during 4 WAP (W_3), hand weeding twice during 4 and 15 WAP (W_4), hand weeding thrice during 4, 12 and 20 WAP (W_5) and hand weeding four times during 4, 8, 12 and 20 WAP (W_6) as sub-plot treatments.

Disease free setts of 20 cm length of cassava variety Sree Vijaya were prepared and planted at a spacing of 90 x 90 cm and planted at the onset of monsoon. Seeds of groundnut, cowpea and black gram were dibbled in lines at a spacing of 30 x 20 cm accommodating two rows of intercrops between the rows of cassava. A fertilizer dose of 90:90:240 NPK Kg ha^{-1} was uniformly applied to all the plots. The entire dose of phosphorus, 50% of recommended

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dose of nitrogen and 50% of K were applied basally at the time of planting and the remaining 50% of the recommended dose of nitrogen and potassium were top dressed in two equal splits at third and fifth month, respectively. The pre-emergence herbicides used in the study viz., pendimathalin, fluchloralin and alachlor are highly selective in nature to control most annual grasses and certain broadleaf weeds in field corn, potatoes, rice, cotton, soybeans, tobacco, peanuts and sunflowers. Incorporated into the soil by cultivation or irrigation is recommended within 7 days following application. Cultural operations pertaining to crop production and protection were followed.

RESULTS AND DISCUSSION

Weed flora

The weed flora in the experimental field consisted of a mixed population of grasses, viz., *Cynodon dactylon* (L.) Pers., sedges *Cyperus rotundus* L. and broad leaved weeds, viz., *Euphorbia hirta*, *Trianthema portulacastrum* and *Achyranthus aspera* as the most dominant species in the experimental plot.

Weed density, dry matter production and weed control efficiency

In general, weed infestation was higher in 2003-04 than in 2004-05. This was mainly because of even distribution of rainfall over entire period of cropping season in 2003-04 as compared to 2004-05 (Fig 1). The results revealed that sedges were found to be dominant followed by grasses and broad leaved weeds. Integrated weed management had noticeable effect on population of of weeds compared to hand weeding alone. Among the different weed management practices, the lowest weed density of grasses (8.25 no/m^2), sedges (14.67 no/m^2), BLW (7.09 no/m^2) and total weed DMP (23.32 g/m^2) was recorded with application of Fluchloralin (0.75kg/ha) + 1HW (Table.1). Regarding the weed control efficiency, intercropping with cowpea registered the highest value of 44.5%. Similarly, application of Fluchloralin (0.75kg/ha) + 1HW resulted in the highest weed control efficiency of 44.6%. Panwar *et al* (1985) also reported that application of fluchloralin at 1 and 2 kg/ha were more effective than two hand weeding on 15 and 30 DAS. The mode of action and selective mechanism of fluchloralin affects the germination of the weed seeds and physiological growth process thereby reducing the weed population (Matsunaka, 1979). With regard to the intercropping practices, significant reduction in the dry matter production (24.80g/m^2) was observed with vegetable cowpea compared to other intercrops. The next best treatment was intercropping of cowpea followed by blackgram with the total weed DMP of 25.07g/m^2 (Table 1). Wilson and Adeniran (1976) reported that intercropping with legumes ensured better coverage of soil thereby diminishing the light penetration to the soil thus reducing the weed growth.

Growth and yield attributes of cassava

Growth attributes of cassava, viz., plant height and DMP revealed highly significant differences due to different weed management and intercropping practices. It could be inferred that the intercrops had definite role on the growth and development of cassava main crop. The mean plant height was the highest (264.95 cm) when vegetable cowpea was sown as intercrop and fluchloralin herbicide combined with one hand weeding at 4 WAP registered increased mean plant height (267.25 cm) (Table 2). Intercropping of cassava

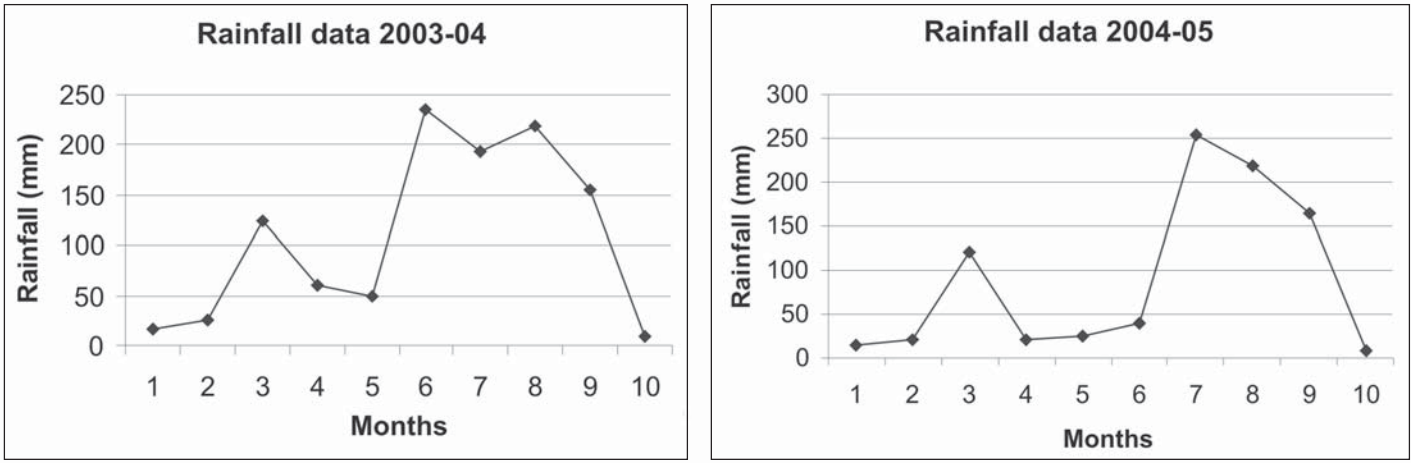

Fig 1. Details of rainfall received during the cropping period

Table 1. Effect of intercropping and weed management practices on weed density, weed dry matter production and weed control efficiency at 60 days

Treatments	Weed density (/ m^2)			Total weed DMP(g/m^2)	Weed control efficiency (%)
	Grasses	Sedges	Broad leaved weeds	Grasses	Sedges
			Intercropping		
Groundnut	11.75(3.50)	16.58(4.13)	7.75(2.87)	27.37(5.28)	40.1
Vegetable Cowpea	9.58(3.18)	13.59(3.75)	10.25(3.28)	24.80(5.03)	44.5
Blackgram	11.59(3.48)	17.00(4.18)	10.00(3.24)	28.85(5.42)	35.9
Groundnut fb Blackgram	11.58(3.48)	16.92(4.17)	9.25(3.12)	28.00(5.34)	37.3
Veg. Cowpea fb Blackgram	9.63(3.19)	13.75(3.78)	10.33(3.29)	25.07(5.06)	43.9
Pure crop	18.83(4.40)	19.83(4.51)	13.09(3.69)	39.20(6.30)	14.0
CD (*P=0.05*)	0.05	0.05	0.21	0.10	0.1
			Weed management		
Pendi.(0.75kg/ha) + 1HW	11.00(3.39)	13.75(3.77)	8.08(2.93)	23.29(4.88)	39.1
Ala.(1.5kg/ha)+1HW	10.67(3.34)	11.75(3.50)	7.50(2.83)	22.45(4.79)	44.1
Flu.(0.75kg/ha) +1HW	8.25(2.96)	14.67(3.90)	7.09(2.76)	23.32(4.88)	44.6
HW twice	13.92(3.80)	20.34(4.57)	12.42(3.60)	34.17(5.89)	13.5
HW thrice	14.92(3.93)	19.84(4.51)	12.92(3.66)	36.10(6.05)	11.7
HW four times	13.92(3.80)	17.34(4.22)	12.67(3.63)	33.96(5.87)	18.8
CD (*P=0.05*)	0.07	0.05	0.17	0.12	0.1

Transformed values (square root) are within parentheses

with cowpea enhanced the plant height and growth attributes of cassava as the quantity of N fixed from the atmosphere by cowpea through microbial symbiosis would have met at least a part of the requirement of cassava which agreed with the results of Sheela and Mohammed Kunju (1988). Cassava intercropped with cowpea produced higher DMP, which was comparable to sole cassava. This effect could be attributed to the complementarity of companion crop of cowpea and the better utilization of biologically fixed N by cassava base crop during latter part of its growth. The work of Chittapur *et al* (1994) on maize-legume-intercropping system extends support to the present finding.

The application of herbicides *viz.*, fluchloralin combined with hand weeding caused significant improvement of yield attributes. This may be due to their effect on reducing crop-weed competition and hence better utilization by crop plants. The treatment fluchloralin (0.75 kg/ha) +1HW increased tuber length (31.5 cm), tuber circumference (25.7 cm) and mean tuber weight (447.9 g) (Table 2). Regarding the different intercrops studied, vegetable cowpea increased tuber length, tuber circumference and mean tuber weight. Kaushik and Gautam (1984) and Verma and Kumar (1985) also reported improvement in yield components due to elimination of severe crop-weed competition.

Table 2. Effect of intercropping and weed management practices on agronomic traits of cassava

Treatments	Plant height (cm)	DM P(t/ha)	Tuber length (cm)	Tuber circumference (cm)	Mean tuber weight/ plant (g)	Tuber yield(t/ha)
			Intercropping			
Groundnut	258.30	13.45	28.7	22.4	434.6	22.8
Cowpea	264.95	13.55	30.5	23.7	434.1	23.7
Blackgram	254.00	13.30	29.6	20.3	434.1	18.4
Groundnut fb Blackgram	238.80	13.40	26.2	20.7	431.2	18.6
Cowpea fb Blackgram	262.55	13.40	29.6	22.6	435.7	23.6
Pure crop	262.00	13.80	29.9	24.9	444.1	24.4
CD (*P=0.05*)	5.40	0.05	0.6	0.5	9.5	0.3
			Weed management			
Pendi.(0.75kg/ha)+1HW	257.45	14.75	30.2	23.7	438.5	23.8
Ala.(1.5kg/ha)+1HW	256.55	14.15	30.1	22.8	439.1	22.4
Flu.(0.75kg/ha)+1HW	267.25	15.25	31.5	25.7	447.9	25.4
HW twice	228.85	11.35	26.0	19.4	424.6	18.4
HW thrice	239.85	11.90	27.3	21.0	431.5	20.0
HW four times	248.00	13.45	29.3	22.0	432.1	21.0
CD (*P=0.05*)	6.20	0.35	0.7	0.6	10.7	0.2

There was a significant influence of weed management and intercropping practices on the tuber yield. The tuber yield per plant ranged from 18.4 to 25.4 t/ha. The highest tuber yield was recorded in sole cassava (24.4 t/ha) followed by cassava intercropped with cowpea, which was comparable with sole cassava. In sole cassava, there was no competition for resources except intra-species competition, which explains the increase in growth and yield parameters and yield. Savithri and Alexander (1995) reported that there was no significant difference in yield of cassava when intercropped with cowpea which is in agreement with the present findings. Pre-emergence application of fluchloralin @ 0.75 kg/ ha + one hand weeding at 4 WAP increased the tuber yield of cassava (25.4 t/ha) compared to other weed management practices (Table 2). The results are in accordance with the findings of Sankaran and Balasubramanian (1981) who reported that the pre-emergence application of fluchloralin reduced the weed population leading to reduced crop-weed competition ultimately increasing the crop yield.

Intercrop yield

Cassava is usually wide spaced and has slow initial development. Hence, intercropping at early stages of crop growth is feasible and usually results in higher total income and reduces soil erosion. The different weed management practices markedly improved the yield of intercrops. Increased yield (0.82 t/ha) of groundnut was recorded in the treatment fluchloralin @ 0.75 kg/ha+ one hand weeding at 4 WAP (I_1W_3). Similarly, in cowpea and blackgram, the same weed management practice resulted in the highest yield of 4.78 t/ha (I_2W_3) and 0.73 t/ha (I_3W_3), respectively (Table 3). Intercropping with groundnut or cowpea has been used as smother crop in cassava + maize mixture to give good weed control, high mixture yield and land equivalent ratio. (Abate, 1992).

Economics

Among the different intercropping and weed management treatments, the highest net income (Rs.62,165) and benefit cost ratio (3.31) was recorded with cowpea as intercrop combined with spraying of pre emergence application of fluchloralin @ 0.75 kg/ha + one hand weeding at 4 WAP (I_2W_3) (Table.3). This was closely followed by the treatment I_5W_3 with a net income of Rs.57,765 and a benefit cost ratio of 3.08. The lowest benefit cost ratio (1.58) was recorded in the pure cropping of cassava with hand weeding thrice on 4, 12 and 20 WAP (I_6W_5).

Table 3. Economics of intercropping and weed management practices in cassava

Treatments	Intercrop yield (t/ha)	Net income (Rs.)	Cost benefit ratio
I_1W_1	0.77	36143	2.21
I_1W_2	0.72	30462	2.01
I_1W_3	0.82	41060	2.38
I_1W_4	0.58	21427	1.70
I_1W_5	0.54	23188	1.74
I_1W_6	0.62	22023	1.68
I_2W_1	4.66	49214	2.82
I_2W_2	4.54	45465	2.67
I_2W_3	4.78	62165	3.31
I_2W_4	3.80	33167	2.20
I_2W_5	3.56	33330	2.16
I_2W_6	4.21	34775	2.17
I_3W_1	0.73	26604	1.97
I_3W_2	0.61	26738	1.97
I_3W_3	0.73	33033	2.21
I_3W_4	0.49	19047	1.68
I_3W_5	0.45	17301	1.60
I_3W_6	0.55	19650	1.65
I_4W_1	0.71	26561	1.87
I_4W_2	0.68	28271	1.91
I_4W_3	0.75	38807	2.27
I_4W_4	0.54	21914	1.70
I_4W_5	0.49	18894	1.59
I_4W_6	0.59	20462	1.61
I_5W_1	4.67	54874	2.97
I_5W_2	4.51	46382	2.65
I_5W_3	4.73	57765	3.08
I_5W_4	3.78	37871	2.34
I_5W_5	3.39	33519	2.13
I_5W_6	4.17	36548	2.20
I_6W_1	-	30566	2.23
I_6W_2	-	28205	2.12
I_6W_3	-	42055	2.69
I_6W_4	-	19747	1.77
I_6W_5	-	15371	1.58
I_6W_6	-	21863	1.79

Hence, it could be concluded that among the different intercropping and weed management practices, growing vegetable cowpea along with pre-emergence herbicide application of fluchloralin @ 0.75 kg/ha + one hand weeding at 4 weeks after planting significantly reduced the weed growth, increased the crop growth, yield attributes, yield and economic returns of cassava with high benefit cost ratio.

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