Research Journal of Agriculture and Biological Sciences, 2(6): 559-563, 2006

Response of Cassava to Irrigation Scheduling and Forage Intercropping

M. Mohamed Amanullah, M. Mohamed Yassin, K. Vaiyapuri,
E. Somasundaram, K. Sathyamoorthi and S. Pazhanivelan

Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-3, India.

Abstract: Field experiments were conducted to find out the level of irrigation and the effect of intercropping on the growth and yield Cassava at Veterinary College and Research Institute, Namakkal, Tamil Nadu during 2001 and 2002. The popular hybrid of cassava H 226 was tried as test crop. The soil of the experimental site was moderately drained, loamy sand. The soils were low in available N, medium in available P and low in available K. The experiments were laid out in a split plot design with three replications. In the main plot, four levels of surface irrigation at 1.0, 0.80, 0.60 and 0.40 IW / CPE ratio to 5 cm depth were compared. Three intercropping systems viz., sole cassava, cassava + maize (var. African tall) and cassava + cowpea (var. CO 5) were assigned to sub plot. Disease free setts of cassava were planted at a spacing of 90 x 90 cm. Two rows of intercrops were sown in between the rows of main crop as additive intercropping series. Seeds of fodder maize and cowpea 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 60:60:150 NPK Kg ha^{-1} was uniformly applied to all the plots. Fertilizers were applied only to the main crop. The results revealed that irrigation at 0.80 IW / CPE ratio registered the highest tuber yield. However this yield was comparable with the tuber yield obtained with irrigation scheduled at 0.60 IW / CPE ratio. The economic evaluation revealed that the BC ratio was higher surface irrigation scheduled at 0.80 IW / CPE ratio followed by irrigation scheduled at 0.60 IW / CPE ratio and were comparable**.** Among the intercropping systems, sole cassava recorded the highest tuber yield and BC ratio followed by cassava intercropped with cowpea and both were comparable. Cassava intercropped with maize recorded the least tuber yield and BC ratio.

Key words: Cassava, irrigation scheduling, intercropping, water use efficiency

INTRODUCTION

Cassava (*Manihot esculenta* Crantz.) commonly known as tapioca in India is a staple food of more than 300 million people and also serves as an important raw material for several industries. Cassava, a long season, wide spaced crop is slow in its initial growth and development and therefore, intercropping a short duration crop may increase the biological efficiency as a whole. Normally, green covers are planted with cassava for a variety of purposes such as cultural weed control, fertility and moisture conservation and forage production[6].

Water for irrigation is becoming both scarce and expensive and necessitates to be utilized in a scientific manner. Scheduling irrigation with its ability of irrigation applications based on crop need have created interest because of decreased water requirements, possible increased production and better quality produce. Among the tuber crops, cassava is the most popular in water deficit areas and its cultivation is gaining importance.In these areas, cassava is generally grown with limited amount of irrigation water. Irrigation requirement of cassava has not been critically examined although response to irrigation was studied. The crop is mostly grown under conventional surface method of irrigation in which major portion of irrigation water is lost by evaporation and deep percolation resulting in lower efficiencies. The climatological approach is increasingly used by scientists for assessing the water requirement of crops. Hence, a field experiment was initiated to find out the optimum ratio of irrigation schedule and also a suitable forage intercrop in Cassava.

MATERIAL AND METHODS

Field experiments were conducted at Veterinary College and Research Institute, Namakkal, Tamil Nadu during 2001 and 2002 to find out the effect of irrigation schedule and intercropping on the growth and yield cassava. The popular hybrid of cassava H 226 was tried as test crop. The soil of the experimental site was moderately drained, loamy sand. The field capacity, permanent wilting point and bulk density were 21.2 %, and 6.2 % and 1.42 g cc^{-1}, respectively. The pH of the soil was neutral with an EC of 0.2 dSm^{-1}. The soils were

Corresponding Author: M. Mohamed Amanullah, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-3, India.

low in available N, medium in available P and low in available K. The experiments were laid out in a split plot design with three replications. In the main plot, four levels of surface irrigation at 1.0, 0.80, 0.60 and 0.40 IW/CPE ratio to 5 cm depth were compared. Three intercropping systems viz., sole cassava, cassava + maize (var. African tall) and cassava + cowpea (var. CO 5) were assigned to sub plot. Disease free setts of cassava were planted at a spacing of 90 x 90 cm. Two rows of intercrops were sown in between the rows of main crop as additive intercropping series. Seeds of fodder maize and cowpea 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 60:60:150 NPK Kg ha^{-1} was uniformly applied to all the plots. Fertilizers were applied only to the main crop. Three hand weeding on 30th, 60th and 90th day after planting was given commonly for all the plots.

Tuber yield of cassava and forage yield of intercrops were recorded at harvest and cost benefit ratio worked out. Cassava tuber equivalent yield was arrived at by equating the green fodder cost to that of the cassava tuber. Total water used and water use efficiency was computed for irrigation treatments. Sole crop of fodder maize and cowpea were raised separately and the yield recorded for calculating LER.

RESULTS AND DISCUSSIONS

Yield Attributes: All the yield attributes viz, number of tubers per plant, tuber length and tuber girth were favourably influenced by the irrigation treatments and irrigation through surface irrigation at 0.80 IW / CPE ratio recorded the highest values followed by surface irrigation at 0.60 IW / CPE ratio. Continuous application of water at optimum levels would have resulted in better nutrient uptake and hence better tuber formation. This is in conformity with the findings of Ayyaswamy and Chinnusamy[1] who reported similar results in cassava.

Among the intercropping systems, sole cassava recorded more number of tubers per plant, higher tuber length and girth and was followed by cassava intercropped with cowpea. In sole cassava, there was no competition for various resources except intra-species competition. This might have paved way for the increase in yield parameters. However, after the harvest of cowpea, the smothering effect was reduced slowly and an improvement in growth parameters was obtained which might cumulatively have contributed for the increase in yield parameters. Savithri and Alexander (10) reported that there was no significant difference in yield parameters of cassava when intercropped with cowpea and this lends support to this present finding.

Cassava Tuber Yield: Tuber yield was significantly influenced by the irrigation treatments and surface irrigation scheduled at IW / CPE ratio of 0.80 registered the highest yield in both the years of study recording the mean tuber yield of 35.1 t ha^{-1}. However, this yield was comparable with irrigation scheduled at 0.60 IW / CPE ratio (Table 1). Tuber yield was the lowest at surface irrigation scheduled at 0.40 IW / CPE ratio to 5 cm depth.

It is quite obvious that continuous application of water at optimum levels would result in higher yield under drip system. Sushama *et al.*[11] reported that the yield of cassava under irrigation scheduled at 0.75 IW/CPE ratio was superior over surface irrigation scheduled at 0.50 IW / CPE ratio, and the per cent yield increase due to irrigation over no irrigation was 51, 46 and 26 at 0.75, 0.5 and 0.25 IW / CPE ratios.

Beyond a certain level of moisture, a slight decrease in yield and moisture was realized as evidenced in irrigated scheduled at 1.0 IW / CPE ratio. Similar result of yield reduction in sweet potato due to irrigation scheduled at IW / CPE ratio of 1.25 and 1.5 was reported[4].

Among the intercropping systems, the highest tuber yield was recorded in sole cassava followed by cassava intercropped with cowpea, which was comparable with sole cassava. The lowest yield was associated with cassava intercropped with maize. In sole cassava, there was no competition for various resources except intra-species competition. This might have paved way for the increase in growth and yield parameters, which would have increased the yield. Karnik *et al.*[5] also reported similar result of higher tuber yield by sole cassava.

Even though cassava intercropped with cowpea recorded lesser yield than sole cassava, the yield reduction was not significant. However, after the harvest of cowpea, the smothering effect was reduced slowly and an improvement in growth and yield parameters was obtained as evidenced in this present study and this might cumulatively have contributed for the increase in yield of cassava. Savithri and Alexander[10] reported that there was no significant difference in yield of cassava when intercropped with cowpea and this lends support to this present finding. Mohamed Amanullah *et al.*[8] also reported similar findings.

The reduction in tuber yield of cassava intercropped with fodder maize might be attributable to the higher competition by maize for resources in the early stages and the resultant effect on the growth and yield parameters up to harvest. Similar yield reduction by intercropping maize in cassava was reported by Ikeorgu and Odurukwe[3] and Olasantan *et al.*[9].

Intercrop Yield: Surface irrigation scheduled at IW/CPE ratio of 0.80 registered the highest green fodder yield in both the years of study. However, the

Table 1: Effect of irrigation regimes and intercropping on yield attributes, tuber yield and cost benefit ratio of cassava

Treatments	Yield attributes						Yield (t ha^{-1})					
	Tubers per plant		Tuber length (cm)		Tuber girth (cm)		Tuber	Fodder		Tuber	Fodder	
							Cassava	Maize	Cowpea	Cassava	Maize	Cowpea
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2001-02	2001-02	2002-03	2002-03	2002-03
A. Irrigation regimes												
D_1 Surface, 5 cm, 0.40 IW / CPE	6.44	6.49	27.9	27.4	16.2	16.5	30.2	8.80	6.90	30.5	9.80	7.80
D_2 Surface, 5 cm, 0.60 IW / CPE	6.74	6.60	29.1	28.3	17.5	17.2	35.2	11.1	7.86	35.9	12.4	8.22
D_3 Surface, 5 cm, 0. 80 IW / CPE	6.75	6.64	29.2	28.5	17.7	17.5	35.7	11.2	7.94	36.4	12.6	8.34
D_4 Surface, 5 cm, 1.00 IW / CPE	6.61	6.55	27.9	27.7	17.0	16.8	34.6	10.1	7.50	35.1	11.6	8.25
SEd	0.09	0.27	0.38	0.37	0.22	0.22	0.13	0.19	0.13	0.31	0.17	0.12
CD (P=0.05)	0.17	0.54	0.75	0.73	0.44	0.45	0.17	0.48	0.33	0.70	0.44	0.31
B. Intercroppingsystems												
I_1 Sole cassava	6.75	6.66	28.7	28.3	17.4	17.4	34.9	-	-	35.6	-	-
I_2 Cassava + maize	6.55	6.50	28.3	27.7	16.8	16.6	32.4	10.3	-	33.1	11.6	-
I_3 Cassava + cowpea	6.62	6.57	28.5	27.9	17.1	16.8	34.5	-	7.54	34.8	-	8.15
SEd	0.01	0.02	0.08	0.07	0.14	0.14	0.40	-	-	0.40	-	-
CD (P=0.05)	0.03	0.05	0.18	0.15	0.30	0.30	0.88	-		0.90	-	-

green fodder yield under surface irrigation scheduled at 0.60 IW / CPE ratio was comparable (Table 1). Green fodder yield was the lowest at surface irrigation scheduled at 0.40 IW / CPE ratio to 5 cm depth.

Tuber Equivalent Yield: Cassava tuber equivalent yield was worked out mainly to evaluate the productivity of the intercropping systems. Since the intercrops tried were of different nature (maize, a cereal and cowpea, a legume), the values of intercrops were equated to the value of main crop and added to the main crop for easy comparison.

Among the irrigation treatments, surface irrigation scheduled at IW/CPE ratio of 0.80 registered the highest tuber equivalent yield in both the years of study. However, the tuber equivalent yield under surface irrigation scheduled at 0.60 IW/CPE ratio was comparable (Table 1). Tuber equivalent yield was the lowest at surface irrigation scheduled at 0.40 IW / CPE ratio to 5 cm depth. The higher tuber equivalent yield registered by the irrigation treatments might be due to the higher yield of both cassava and the respective intercrops.

Cassava intercropped with cowpea registered the highest tuber equivalent yield than the other systems (Table 2). This might be due to the obvious reason of higher productivity of cassava in cassava + cowpea intercropping, comparable to the yield in sole crop and the cost of cowpea which was more than the cost of maize. Similar result of higher tuber equivalent yield recorded under cassava + cowpea intercropping system reported by Mohamed Amanullah *et al.*[8] lend support to this finding.

Land Equivalent Ratio (LER): Among the irrigation treatments, irrespective of the intercrops, higher LER was recorded in surface irrigation scheduled at IW/CPE ratio of 0.80 (Table 2). This might be due to the higher yield recorded by both cassava and the intercrops under the respective treatments.

Among the intercropping systems, cassava intercropped with cowpea registered higher LER than cassava intercropped with maize. The increased yield of base crop of cassava in cassava intercropped with

Table 2: Effect of intercropping and irrigation regimes on tuber equivalent yield (t ha^{-1}), LER and BC ratio

Treatments	2001-2002			2002-2003		
	Tuber Equivalent yield	LER	BC ratio	Tuber Equivalent yield	LER	BC ratio
A. Irrigation regimes						
D_1 Surface, 5 cm, 0.40 IW / CPE	32.2	1.28	2.73	33.9	1.34	2.78
D_2Surface, 5 cm, 0.60 IW / CPE	37.6	1.37	2.96	38.5	1.41	3.03
D_3 Surface, 5 cm, 0. 80 IW / CPE	38.1	1.38	3.01	39.1	1.43	3.04
D_4 Surface, 5 cm, 1.00 IW / CPE	37.1	1.34	2.86	38.2	1.40	2.95
SEd	0.03	-	-	0.04	-	-
CD (P=0.05)	0.07	-	-	0.07	-	-
B. Intercropping systems						
I_1 Sole cassava	34.9	-	2.885	35.6	-	2.95
I_2 Cassava + maize	36.4	1.29	2.83	37.6	1.35	2.88
I_3 Cassava + cowpea	37.6	1.39	2.96	38.9	1.43	3.03
SEd	0.43	-	-	0.42	-	-
CD	0.95	-	-	0.90	-	-

Table 3: Total water used and water use efficiency in different irrigation treatments (mean over two years)

Particulars	Irrigation regimes			
	Surface irrigation at 0.40 IW / CPE	Surface irrigation at 0.60 IW / CPE	Surface irrigation at 0.80 IW / CPE	Surface irrigation at 1.00 IW / CPE
Irrigation water applied (mm)	598	639	660	702
Effective rainfall (mm)	336	336	336	336
Total water used (mm)	934	975	996	1038
Tuber equivalent yield (kg ha^{-1})	33050	38010	38640	37660
Water use efficiency (kg ha^{-1} mm)	35.3	38.9	38.8	36.2

cowpea, than cassava intercropped with maize might be the plausible reasons for such increase. The higher LER value reported in cassava + cowpea combination by Mason *et al.*[7] and similarly higher LER values in cassava + maize intercropping by Ezumah *et al.*[2] are concomitant to this finding.

Water Use Efficiency: Surface irrigation scheduled at 0.60 IW/CPE ratio has consumed 975 mm of water for the whole period with a water use efficiency of 38.9 kg ha^{-1} mm (Table 3). This was followed by surface irrigation scheduled at 0.80 IW / CPE ratio with a consumption of 996 mm and WUE of 38.8 kg ha^{-1} mm.

Economics: The economic evaluation of the results revealed that the BC ratio was higher under surface irrigation scheduled at 0.80 IW / CPE ratio. However, the BC ratio obtained under surface irrigation scheduled at 0.60 IW / CPE ratio was comparable. Surface irrigation scheduled at 0.40 IW / CPE ratio recorded the least BC ratio.

Conclusion: It can be concluded that in areas where there is no water scarcity, surface irrigation scheduled at 0.80 IW / CPE ratio could be recommended for getting higher yield. In moderate water scarcity areas, surface irrigation scheduled at 0.60 IW / CPE ratio could be recommended for getting higher yield in cassava. Intercropping forage cowpea in cassava could fetch additional revenue without consuming additional water and affecting the yield of cassava.

REFERENCES

1. Ayyaswamy, M. and C. Chinnusamy. 1996. Effect of irrigation regimes, comrade cropping and soil amendments on biochemical analysis, N, P and K uptake and yield of cassava and groundnut. Madras Agric. J., 83 (2): 103 – 106.

2. Ezumah, H.C., J. Arthur and J. Fajemisin. 1990. Maize (*Zea mays*) genotypes for intercropping with cassava (*Manihot esculenta*) in Southern Nigeria. 2. Growth and morphological changes and yield advantages. Discovery and Innovation,2(2): 73-82.
3. Ikeorgu, J.E.G. and S.O. Odurukwe. 1993. Production of Nigeria's elite cassava cultivars grown in mixture with eleven contrasting maize genotypes. In: Proc. of 4th Symp. on Tropical root crops. Ibadan, Nigeria.
4. Indira, P. and S. Kabeerathumma, 1990. Physio metabolic changes in sweet potato grown under different levels of moisture. J. Root Crops. 16 (1): 28-32.
5. Karnik, A.R., U.B. Apte, B.B. Jadhav and R.G. Wagh. 1993. Intercropping of legumes and vegetables with rainfed cassava (*Manihot esculenta*). Indian J. Agric. Sci., 63(5): 265-267.
6. Leihner, D.E. 1980. Cultural control of weeds in cassava. *In*: Proc. Int. Workshop on cassava cultural practices. *Eds*. E.J. Weber, M.J.C. Tora and M. Graham. IDRC, Ottawa, Canada. Series 151 e: pp:107-111.
7. Mason, S.C., D.E. Leihner and J.J. Vorst. 1986. Cassava - cowpea and cassava - peanut intercropping I. Yield and Land Use Efficiency Agron. J., 78(1): 43-46.
8. Mohamed Amanullah, M., A. Alagesan, K. Vaiyapuri, S. Pazhanivelan and K. sathyamoorthi. 2006. Intercropping and organic manures on the growth and yield of Cassava (Manihot esculenta Crantz.) Res. J. Agric. Biol. Sci., 2 (4): 200-206.
9. Olasantan, F.O., H.C. Ezumah and E.O. Lucas. 1997. Response of cassava and maize to fertilizer application, and a comparison of the factors affecting their growth during intercropping. Nutrient cycling in Agro ecosystems, 46: 215 -223.
10. Savithri, K.E. and D. Alexander. 1995. Performance of cowpea varieties in cassava-cowpea intercropping system. Legume Res., 18(1): 59-60.
11. Sushama, P.K., and G.R. Pillai, T.P. George and Jose Mathew. 1982. Response of cassava to different irrigation in schedules. *J. Root Crops*, 8 (1&2): 71-73.