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# Growth and Yield of Cassava as Influenced by Drip Irrigation and Organic Manures

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**Abstract:** Field experiments were conducted at Veterinary College and Research Institute, Namakkal, Tamil Nadu during 2002 and 2003 to find out the efficiency of drip irrigation and effect of organic manures 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 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, surface irrigation at 0.60 IW / CPE ratio to 5 cm depth was compared with drip irrigation once in two days at three levels viz., 100, 75 and 50 per cent of surface irrigation. Three organic manurial treatments viz., FYM (25 t $ha^{-1}$), Poultry manure (10 t $ha^{-1}$) and composted poultry manure (10 t $ha^{-1}$) were assigned to sub plots. Disease free setts of cassava were planted at a spacing of 90 x 90 cm. A fertilizer dose of 60:60:150 NPK Kg $ha^{-1}$ was uniformly applied to all the plots. The results indicated that irrigation through drip once in two days at 100 % of surface method registered the highest mean tuber yield of 36.0 t $ha^{-1}$. However the tuber yield at 100 % and 75 % of irrigation through drip were comparable. The least tuber yield was associated with surface irrigation at 0.60 IW / CPE ratio. The saving of water under drip irrigation at 75 % of surface irrigation was 32 % of surface method. Higher BC ratio was recorded with irrigation through drip at 100 % of surface irrigation followed by 75 % of surface irrigation. Composted poultry manure recorded the highest yield among the organic manures. Higher net return and BC ratio were obtained with application of composted poultry manure.

**Key words:** Cassava, drip irrigation, composted poultry manure, 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. Water for irrigation is becoming both scarce and expensive and necessitates to be utilized in a scientific manner. Drip irrigation with its ability of small and frequent irrigation applications have created interest because of decreased water requirements, possible increased production and better quality produce. Cassava is an important crop of water deficit areas of Kerala and Tamil Nadu state, where in it is generally grown with limited amount of irrigation water. Cassava is the most popular tuber crop in water deficit areas and its cultivation is gaining importance. 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.

Drip irrigation has proved to be a success in terms of water and increased yield in a wide range of crops[1]. However the system is generally most successful for high-income crops because of the relatively high initial cost of most installations. The use efficiency of both water and fertilizers could be increased substantially through drip irrigation.

Application of organic manures has various advantages like increasing soil physical properties, water holding capacity, and organic carbon content apart from supplying good quality of nutrients. Poultry manure is a rich organic manure since solid and liquid excreta are excreted together resulting in no urine loss. In fresh poultry excreta uric acid or urate is the most abundant nitrogen compound while urea and ammonium are present in small amounts[3].

The nutritional value of unprocessed poultry manure deteriorates rapidly. Hence, the immediate processing of poultry manure to prevent its rapid decomposition and save its nutrient properties is, thus essential. Composting or the biological degradation of poultry manure helps for greater recovery of final product and negligible loss of nutrients particularly nitrogen[2]. Hence, with these ideas in view, the present study has been aimed to optimize the irrigation

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requirement of cassava thorough drip system of irrigation and to find out the effect of composted poultry manure on the yield and economics of cassava.

## MATERIAL AND METHODS

Field experiments were conducted at Veterinary College and Research Institute, Namakkal, Tamil Nadu during 2002 and 2003 to find out the efficiency of drip irrigation and effect of organic manures 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 pH of the soil was neutral with an EC of 0.2 $dSm^{-1}$. 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, surface irrigation at 0.60 IW / CPE ratio to 5 cm depth was compared with drip irrigation once in two days at three levels viz., 100, 75 and 50 per cent of surface irrigation. Three organic manurial treatments viz., FYM (25 t $ha^{-1}$), poultry manure (10 t $ha^{-1}$) and composted poultry manure (10 t $ha^{-1}$) were assigned to sub plots. Disease free setts of cassava were planted at a spacing of 90 x 90 cm. A fertilizer dose of 60:60:150 NPK Kg $ha^{-1}$ was uniformly applied to all the plots. Three hand weeding on 30th, 60th and 90th day after planting was given commonly for all the plots.

For drip irrigation, drip lateral was laid out at 90 cm spacing between rows. Drippers were placed at 90 cm apart along the lateral line with a discharge capacity of 4 lph each. The quantity of water in drip irrigation treatments was worked out based on daily pan evaporation value (for e.g. Drip irrigation at 100 per cent of surface = 1.0 x 0.6 x pan evaporation in mm).

Composting of poultry manure was initiated using poultry manure and chopped sorghum straw. The bits of sorghum straw were mixed with poultry manure at the rate of 1:10 and packed in dug pits and closed with mud plaster. To maintain optimum moisture, water was sprinkled before it is being packed and left under anaerobic conditions for 75 days as suggested by Sims *et al*.[9] for composting poultry manure and poultry carcasses. The chemical analysis of the manures is furnished in Table 1.

Growth parameters and tuber yield of cassava were recorded at harvest and cost benefit ratio was worked out. The number of storage tubers of five plants was counted and the mean was expressed in number per plant. The length of storage tubers of five plants was measured and the mean was expressed in cm. The maximum girth of cassava tubers was measured for ten tubers at random and expressed in cm. Total water used and water use efficiency was computed for irrigation treatments.

**Table 1:** Chemical analysis of FYM and poultry manure

| Particulars | FYM | Poultry manure | Composted poultry manure |
|---|---|---|---|
| N content (%) | 0.55 | 2.20 | 1.92 |
| P content (%) | 0.48 | 1.41 | 1.35 |
| K content (%) | 0.90 | 1.52 | 1.55 |
| p H (1:2 soil water extract) | 7.60 | 6.40 | 7.10 |
| C: N ratio | 20.8 | 11.8 | 16.9 |

## RESULTS AND DISCUSSIONS

**Dry matter production (DMP):** Dry matter production was significantly influenced by the irrigation treatments and irrigation through drip at 100 per cent of surface method of irrigation registered the highest DMP in both the years of study (Table 2). However, the DMP at 100 per cent and 75 per cent of irrigation through drip were comparable. DMP was the lowest at surface irrigation scheduled at 0.60 IW / CPE ratio to 5 cm depth. Irrigation scheduled through drip at 50 per cent of surface irrigation produced DMP on par with surface irrigation in both the years of study.

Among the organic manures, composted poultry manure registered higher dry matter at all the stages of crop growth. Application of composted poultry manure might have provided a continuous supply of nutrients and might have enabled the LAD to extend and thus providing an opportunity for the plants to increase the photosynthetic rate, which could have led to the higher accumulation of dry matter. Higher dry matter in sorghum due to application of poultry litter was reported by Savithri *et al*.[6]. Mohamed Amanullah *et al*.[5] also obtained higher DMP in cassava due to application of composted poultry manure.

**Yield attributes:** Among the yield attributes, mean number of tubers per plant was favourably influenced by the irrigation treatments and irrigation through drip at 100 per cent of surface irrigation recorded the highest values (Table 3). Similarly tuber length and tuber girth showed positive response to drip irrigation treatments recording higher values as compared with that of surface irrigation. It is quite obvious that continuous application of water at optimum levels would result in improvement in yield attributes under drip system. Manickasundaram *et al*.[4] also reported similar results of improvement in yield attributes of cassava due to irrigation through drip at 75 % of surface irrigation.

Among the organic manures, composted poultry manure registered more numbers of tubers per plant, higher tuber length and tuber girth. The favourable conditions created in the soil due to increased nutrient

**Table 2:** Effect of drip irrigation and organic manures on the dry matter production (t $ha^{-1}$) of Cassava

| Treatment | 2002-2003 | | | | | 2003-2004 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 60 DAP | 120 DAP | 180 DAP | 240 DAP | Harvest | 60 DAP | 120 DAP | 180 DAP | 240 DAP | Harvest |
| A. Irrigation regimes | | | | | | | | | | |
| $D_1$ Surface, 5 cm, 0.60 IW / CPE | 0.60 | 2.30 | 8.20 | 15.9 | 21.9 | 0.59 | 2.09 | 7.84 | 15.4 | 21.1 |
| $D_2$ Drip at 100 per cent of surface | 0.64 | 2.48 | 8.87 | 17.3 | 24.1 | 0.65 | 2.34 | 8.73 | 17.3 | 23.7 |
| $D_3$ Drip at 75 per cent of surface | 0.61 | 2.36 | 8.44 | 16.5 | 23.0 | 0.64 | 2.31 | 8.64 | 16.9 | 22.4 |
| $D_4$ Drip at 50 per cent of surface | 0.60 | 2.31 | 8.25 | 16.1 | 22.4 | 0.63 | 2.29 | 8.54 | 16.2 | 21.9 |
| $SE_d$ | 0.01 | 0.06 | 0.12 | 0.24 | 0.30 | 0.01 | 0.04 | 0.12 | 0.24 | 0.30 |
| CD (P=0.05) | 0.03 | 0.13 | 0.25 | 0.50 | 0.70 | 0.02 | 0.09 | 0.25 | 0.50 | 0.70 |
| B. Organic manures | | | | | | | | | | |
| $M_1$ FYM (25 t $ha^{-1}$) | 0.58 | 2.20 | 8.15 | 16.1 | 22.4 | 0.59 | 2.18 | 8.24 | 16.4 | 22.3 |
| $M_2$ PM (10 t $ha^{-1}$), | 0.60 | 2.25 | 8.34 | 15.9 | 22.2 | 0.61 | 2.19 | 8.08 | 16.1 | 21.4 |
| $M_3$ CPM (10 t $ha^{-1}$) | 0.68 | 2.49 | 8.89 | 17.4 | 23.9 | 0.69 | 2.38 | 8.99 | 17.2 | 23.4 |
| $SE_d$ | 0.01 | 0.03 | 0.08 | 0.15 | 0.21 | 0.01 | 0.02 | 0.07 | 0.14 | 0.20 |
| CD (P=0.05) | 0.02 | 0.06 | 0.18 | 0.33 | 0.45 | 0.02 | 0.05 | 0.15 | 0.30 | 0.42 |

**Table 3:** Effect of drip irrigation and organic manures on yield attributes, tuber yield and cost benefit ratio of Cassava

| Treatments | Yield attributes | | | | | | Tuber Yield (t $ha^{-1}$) | | BC Ratio | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tubers per plant | | Tuber length (cm) | | Tuber girth (cm) | | 2002-03 | 2003-04 | | |
| | 2002-03 | 2003-04 | 2002-03 | 2003-04 | 2002-03 | 2003-04 | | | 2002-03 | 2003 -04 |
| A. Irrigation regimes | | | | | | | | | | |
| Surface, 5 cm, 0.60 IW / CPE | 6.44 | 6.49 | 27.9 | 27.4 | 16.2 | 16.5 | 32.2 | 32.5 | 3.23 | 3.25 |
| Drip at 100 per cent of surface | 6.75 | 6.64 | 29.2 | 28.5 | 17.7 | 17.5 | 35.7 | 36.4 | 1.91 | 3.65 |
| Drip at 75 per cent of surface | 6.74 | 6.60 | 29.1 | 28.3 | 17.5 | 17.2 | 35.2 | 35.9 | 1.80 | 3.52 |
| Drip at 50 per cent of surface | 6.44 | 6.46 | 27.2 | 26.6 | 16.3 | 16.3 | 31.6 | 32.4 | 1.72 | 3.30 |
| SEd | 0.09 | 0.07 | 0.38 | 0.37 | 0.22 | 0.22 | 0.48 | 0.42 | - | - |
| CD (P=0.05) | 0.17 | 0.14 | 0.75 | 0.73 | 0.45 | 0.45 | 1.00 | 0.90 | - | - |
| B. Organic manures | | | | | | | | | | |
| $M_1$ FYM (25 t $ha^{-1}$) | 6.44 | 6.39 | 27.8 | 27.4 | 16.8 | 16.6 | 32.9 | 34.4 | 2.06 | 3.18 |
| $M_2$ PM (10 t $ha^{-1}$), | 6.42 | 6.38 | 27.6 | 27.2 | 16.5 | 16.5 | 31.8 | 33.6 | 2.02 | 3.12 |
| $M_3$ CPM (10 t $ha^{-1}$) | 6.88 | 6.88 | 29.7 | 28.6 | 17.4 | 17.6 | 36.4 | 37.6 | 2.43 | 3.96 |
| SEd | 0.02 | 0.02 | 0.11 | 0.14 | 0.11 | 0.12 | 0.33 | 0.34 | - | - |
| CD (P=0.05) | 0.04 | 0.04 | 0.23 | 0.30 | 0.25 | 0.25 | 0.70 | 0.72 | - | - |

availability and the resultant uptake owing to high nutrient content of the manures might have complemented the tuber length and girth, which corroborated with the findings of Mohamed Amanullah *et al.*[5].

**Cassava tuber yield:** Tuber yield was significantly influenced by the irrigation treatments and irrigation through drip at 100 per cent of surface method of irrigation registered the highest yield in both the years study recording the mean tuber yield of 36.1 t $ha^{-1}$ which was significantly superior over surface irrigation scheduled at 0.60 IW / CPE ratio (Table 3). However, tuber yield at 100 per cent and 75 per cent of irrigation through drip were comparable. Tuber yield was the lowest at surface irrigation scheduled at 0.60 IW / CPE ratio to 5 cm depth. Irrigation scheduled through drip at 50 per cent of surface irrigation produced tuber yields on par with surface irrigation in both the years of study.

It is quite obvious that continuous application of water at optimum levels would result in higher yield under drip system. Selvaraj *et al.*[8] reported that the fresh rhizome yield of turmeric under drip irrigation scheduled at 80 per cent of surface irrigation was superior over surface irrigation scheduled at 0.90 IW/CPE ratio. Bhardwaj[1] reported 100 per cent yield increase in banana, 40 to 50 per cent in sugarcane, pomegranate and 25 per cent in grapes and cotton under drip method of irrigation. Selvaraj *et al*.[7] also reported 32 per cent yield increase in sugarcane under drip irrigation system over surface method.

Among the organic manures, composted poultry manure recorded higher tuber yield than other manures suggesting the importance of composting poultry manure. Higher tuber yield due to CPM could be attributed to slow and steady availability of nutrients throughout the crop growth period from CPM.

Adequate biomass production, better nutrient uptake and improvement in yield parameters might have resulted in higher tuber yield consequent to application of composted poultry manure. Enrichment of soil N and P in available form by the addition of composted poultry manure might be responsible for good performance by CPM besides their higher NPK content compared to FYM. Mohamed Amanullah *et al*.[5] reported similar result of higher yield of cassava due to composted poultry manure. Even though poultry manure had higher N than composted poultry manure, it did not record higher yield. The immediate mineralization of N after application, at the stage, the plant had not even sprouted and the resultant loss of N by ammonia volatilization might be the reason for the relatively lesser yield recorded under poultry manure. Wolf *et al.* [11] reported that 37 per cent of N in poultry manure was volatilized in 11 days after application, which might reduce the availability of N for plant uptake and this is concomitant to this result. Another ostensible reason might be the narrower C: N ratio of poultry manure. Low C: N ratio might have favoured aerobic fermentation in the field resulting in loss of Co2 and ammonia, thus reducing the nutrients especially N for plant uptake.

**Water use efficiency:** Irrigation through drip at 75 per cent of surface has consumed 988 mm of water for the whole period with water saving of 32.3 per cent and recorded the water use efficiency of 36.0 kg $ha^{-1}$ mm (Table 4). The percent saving in irrigation water under drip irrigation scheduled at 50 per cent of surface irrigation was 52.1 per cent compared to that of surface method of irrigation. The water use efficiency was 22 to 51 per cent higher in drip irrigation compared to that of surface method. These results are in conformity with the findings of Selvaraj *et al*.[7,8] in sugarcane and turmeric. In banana, saving in irrigation water to the tune of 70 per cent was achieved besides improvement in yield and quality[10]. Bhardwaj[1] reported 40 to 70 per cent saving in irrigation water compared to conventional method of irrigation in a wide range of crops. Manickasundaram *et al*.[4] reported similar result in tapioca.

**Economics:** The economic evaluation of the results revealed that the net return and BC ratio were higher under drip irrigation treatments compared with that of surface irrigation. However the cost benefit ratio was higher under surface irrigation in the first year of study owing to high initial installation cost of drip system.

**Table 4:** Total water used and water use efficiency in different irrigation treatments(mean over two years)

| Particulars | Irrigation regimes | | | |
|---|---|---|---|---|
| | Surface irrigation | Drip at 100 per cent of surface | Drip at 75 per cent of surface | Drip at 50 per cent of surface |
| Irrigation water applied (mm) | 840 | 730 | 568 | 402 |
| Irrigation water saving (per cent) | - | 13.1 | 32.3 | 52.1 |
| Effective rainfall (mm) | 420 | 420 | 420 | 420 |
| Total water used (mm) | 1260 | 1150 | 988 | 822 |
| Tuber yield (kg $ha^{-1}$) | 32350 | 36050 | 35550 | 32000 |
| Water use efficiency (kg $ha^{-1}$ mm) | 25.7 | 31.3 | 36.0 | 38.9 |
| Percent increase in WUE | - | 21.8 | 48.0 | 51.4 |

Among the organic manures, higher BC ratio was recorded by CPM. The higher BC ratio recorded by this treatment could be attributed to the higher yield obtained due to application of CPM.

**Conclusion:** It can be concluded that in moderate water scarcity areas, drip irrigation once in two days at 75 per cent of surface irrigation could be recommended for getting higher yield in cassava. In areas where water is very scarce, drip irrigation at 50 per cent of surface irrigation can be recommended to obtain yields on par with conventional surface irrigation with water saving of about 50 per cent. Composting of poultry manure can be recommended for conserving N and getting higher yield and returns.

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