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Productivity and Profitability of Cassava under Drip Fertigation

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Abstract

Productivity and profitability of cassava under drip fertigation and rain fed cultivation was worked out, based on the data collected from field experiments carried out at ICAR-CTCRI, Thiruvananthapuram, during the period 2014-15, 2015-16 and 2016-17. The trial was conducted by planting mini setts of short duration variety cassava, "Sree Vijaya" with three levels each of nitrogen and potassium in factorial design along with a control (rainfed crop with soil application of fertilizers). The tuber yield was 2 to 3 times higher under drip fertigation compared to rainfed crop. The mean data over a period of three years indicated that drip fertigation @ 75 kg nitrogen and 125 kg potash resulted in maximum tuber yield, gross and net income and B:C ratio in cassava. Drip fertigation is profitable in cassava, especially in the industrial belts, and N and K @ 75: 125 kg ha^{-1} could result in 4.4 times increase in net income and 67% increase in B:C ratio.

Key words: Cassava, B:C ratio, drip fertigation, productivity, profitability

Introduction

Cassava (*Manihot esculenta* Crantz), commonly called tapioca, is an important staple food in the tropics and ranked as fourth most important source of calories in human diet worldwide. More than a food crop, the industrial potential of cassava is well recognized nowadays as for the production of native and modified starch, and bioethanol apart from its use as cattle feed. In India, cassava is cultivated in approximately 0.23 mha mainly covering, Tamil Nadu, Kerala, Andhra Pradesh, Maharashtra, Chhattisgarh and North eastern states with a total production of 8.14mt. India ranks first in productivity (35.65 t ha^{-1}) compared to the world average of 11.2 t ha^{-1} (FAO STAT, 2014). In Kerala, North eastern states and Maharashtra, the crop is cultivated under rainfed conditions. However in the industrial belts of Tamil Nadu and Andhra Pradesh it is grown under protective irrigation and fertigation. In Tamil Nadu almost 40% of the cultivated area is under drip irrigation. Tamil Nadu ranks first in terms of cassava productivity among the states, the main reason being irrigation. The farmers get almost double the tuber yield, under drip irrigation compared to rainfed crop. Cassava is known as a drought resistant crop, but it has shown positive response to supplemental irrigation (Odubanjo et al., 2011, Sunitha et al., 2013).

Precise application of water as well as nutrients is the need of the hour to improve the use efficiencies of scarce commodity of water and nutrients. So wherever cassava is raised under irrigated conditions, micro irrigation as well as fertigation should go side by side in order to realise the full tuber yield potential of cassava, especially in the industrial belts. But the farmers have to incur a reasonable amount towards initial installation of the micro irrigation facilities. However in the long run, it would be profitable in terms of higher yield and income. In this study, an attempt was made to work out the productivity and profitability of cassava cultivation raised through mini

setts under differenet levels of drip fertigation, in comparison to rainfed cultivation.

Materials and Methods

Field experiments were conducted in cassava consecutively for three years, 2014-15, 2015-16 and 2016-17 at ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala, India during summer season to make use of the dry spell from December to May. Soil of the experimental site was Typickandiustult (Order: Ultisol) having pH towards acidic range (5.1), low in available nitrogen (79.3 kg/ha) and medium in available phosphorus and potassium (25.6 & 147.8 kg/ha). The location received an average of less than 300 mm rainfall during all the growing seasons. Short duration variety (6 months) of cassava developed by ICAR- CTCRI, 'Sree Vijaya' was used for the study. The experiment was laid out in 3^2 factorial design with nine treatments (three levels each of two nutrients viz., nitrogen and potassium) in three replications. The three levels of nutrients tried in the study were 75, 100 and 125 kg/ha each of nitrogen and potassium applied through drip fertigation. A control of standard recommended dose of fertilizers (100-50-100 kg NPK/ha) applied as soil application was kept as control for comparison.

Minisetts of cassava (two node cuttings) were initially planted in a nursery during November (George et al., 2004). Seedlings with two to three fully opened leaves were uprooted and transplanted after four weeks in the main field. Transplanting was done on ridges made at a distance of 60 cm and planting was done at a spacing of 45 cm. After ridge formation, drip system was laid out and drippers were placed so as to coincide with the spacing of the minisetts. Each plot had 36 plants with a net plot size of 16 plants. At the time of land preparation, Farm Yard Manure @ 12.5 t/ha and full dose of phosphorus fertilizer were applied as basal. Irrigation was given at the rate of 100% cumulative pan evaporation (Sunitha et al., 2013) from December to April. For initial two weeks, irrigation was given daily for establishment of minisetts and thereafter on alternate days upto 5 months. Fertigation was given at weekly intervals as per schedule, starting from the second week of transplanting and upto a period of 120 days after planting. Fertigation schedule was fixed based on earlier findings in cassava (Sunitha et al., 2013) with urea and muriate of potash as N and K sources. 50% of N and K dose was applied during the initial 6 weeks (6 splits), 30 % dose during 6-12 weeks (6 splits) and remaining 20% was given during 12-18 weeks period (5 splits).

The crop was harvested after 6 months , yield attributes and tuber yield were recorded from different treatments from the net plot during the three growing seasons and estimated on per hectare basis. The data over the years were pooled and analysed statistically following SAS analytical procedure (SAS,2010). Economic indices viz., cost of cultivation, gross income, net income and benefit, cost ratio were worked out based on various inputs and labour costs at the end of three years.

Results and Discussion

Cassava tuber yield

Data on tuber yield were collected from differenet fertigation treatments every year and were pooled over the three years. Pooled data analysis of three years indicated that, tuber yield of cassava per hectare was on par under different levels of nitrogen. However, increasing levels of K from 75 to 125 kg resulted in increase in tuber yield. Higher two levels, 100 and 125 kg ha^{-1} of potassium were on par with respect to tuber yield. Different combinations of nitrogen and potassium resulted in more or less same tuber yield, except N and K @ 75:75, and 100: 75 kg ha^{-1}. The combination effect of N @ 75 and K @ 125 kg ha^{-1} recorded the maximum tuber yield (48.68 t ha^{-1}). Application of 25 kg more of potash alone resulted in 37% increase in tuber yield and 50 kg more of potash resulted in 44% increase compared to 75 kg ha^{-1} of potash (Table 3).

Irrigation was given uniformly to all the treatments depending upon the growth stages upto a period of 150 days. Hence the variation in tuber yield was only due to the nutrient levels, especially K under irrigated conditions. Though cassava thrives in poor and marginal soils, it responds well to added fertilizers, especially potash. Potassium is reported to be a critical element in tuber crops for starch translocation during active tuber bulking phase, but is an element subjected to maximum loss by way of leaching. The importance of potassium in

translocation of carbohydrates in cassava has been reported by earlier workers (Mohankumar, 2000). However the crop needs a continuous supply of nutrients during the active tuber bulking stage. This is evident from the studies at ICAR-CTCRI wherein application of 50 % N and K during first 40 days and remaining 30 % during 40-80 days and the rest 20% during 80-120 days after planting resulted in maximum tuber yield in short duration variety, Sree Vijaya through fertigation (Sunitha et al, 2016).

Fertigation is established to be a nutrient efficient package in most of the crops wherein the nutrients are applied in smaller quantities over a longer spell of crop requirement in the active root zone of the crop. When fertilizer is applied through drip irrigation, the yield could be increased and about 30 per cent of the fertilizer could be saved (Sivanappan and Ranghaswami, 2005). So application of nutrients especially potassium in more splits in the active root zone of the crop with adequate amount of moisture helped in better uptake of nutrients and subsequent crop performance.

Cost of raising mini sett nursery

A nursery area of 125 m^2 is required for raising mini setts for transplanting into one ha of main field, which incurred an amount of ` 13600/- during every year (Table1).

Table 1. Cost of raising mini sett nursery of cassava (Pooled mean of three years)

Item	Man days/Qty.	Cost(`)
Mini sett nursery		
Preparation of beds	4 M	2400
Making minisetts	10 W	5000
Planting minisetts	10 W	5000
Nursery maintenance	2 M	1200
Total		13600

Cost of installation of micro irrigation

The cost of irrigation materials depends mainly on the distance of the field from the water source. Since mini setts are planted at a closer spacing of 60 x 45 cm, more number of drippers are required. The total cost of installation in one ha of area comes to be about ` 2.0 lakhs (Table 2) including accessories and installation charges. After considering the depreciation, maintenance cost etc during subsequent years, the cost of fertigation unit comes to about ` 58520/- per year.

Table 2: Cost of installation of drip fertigation, Area : 1 ha (Fixed cost)

No.	Particulars	Cost of laterals, drippers etc (`)	Cost of pipes, valve, motor, filters etc(`)
1	Fixed cost (x 10^3)	125	75
2	Life year	6	20
3	Depreciation (x 10^3)	20.83	3.75
4	Interest (12%) (x 10^3)	15	9
5	Repair and maintenance (2%(x 10^3)	2.5	1.5
	Total (x 10^3)	38.33	14.25
	Grand total (x 10^3)	52.58	

Cost of cultivation

The cost of cultivation of mini setts of cassava under different levels of drip fertigation was worked out and it ranged from ` 153,900 to ` 155,500/-, the minor variation is mainly due to the difference in cost of N and K fertilizers. (Table 3) Under rainfed conditions, the cost of cultivation was only ` 85,800/-per ha.

Gross income and net income

The gross income ranged from ` 3,38,200 to ` 4,86,800/- under different fertigation treatments and net income from ` 184300/- to ` 331900/- per ha. Gross and net income from rainfed crop was ` 1,61,100 and ` 75,300/- respectively. The maximum net income was obtained from the fertigation treatment N1K3, ie, 75 kg of nitrogen and 125 kg of potash. The minimum was for N1K1, ie, 75 each of nitrogen and potash. Positive response from more potash through fertigation (125 kg) was evident from more tuber yield , which consecutively resulted in more gross and net income also. Fertigation resulted in 2.4 to 4.4 times net income compared to rainfed control with soil application of fertilizers.

Table 3. Tuber yield and economics of cassava cultivation under drip fertigation and rainfed conditions

Treatment N:K	Tuber yield (t/ha)	Cost of cultivation (`)	*GrossNet income(`)	B:C Ratio
75:75	33.82	153900	338200	184300	2.197
75:100	45.01	154400	450100	295700	2.915
75:125	48.68	154900	486800	331900	3.142
100:75	37.43	154200	374300	220100	2.427
100:100	47.09	154700	470900	316200	3.044
100:125	43.02	155200	430200	275000	2.771
125:75	45.13	154600	451300	296700	2.919
125:100	40.57	155100	405700	250600	2.615
125:125	46.85	155500	468500	313400	3.012
Control	16.11	85800	161100	75300	1.877
CD	8.422	—	—	—	0.42

***** Price of cassava tubers @ ` 10000/- per tonne

B:C Ratio

B:C ratio also followed a similar trend as in gross and net income. The ratio ranged from 2.19 to 3.14 with fertigation, whereas rainfed control recorded the lowest B:C ratio of 1.87. Similar increase in corm yield, gross and net income and B:C ratio under drip fertigation over flood irrigation due to increased water and nutrient use efficiencies in elephant foot yam , has been reported (Nedunchezhiyan, 2017).

Productivity, profitability and relative economic efficiency

The crop was of short duration (180 days) and productivity in terms of tuber yield and profitability in terms of profit/ day were worked out. The productivity was 2 to 3 times and profitability/ ha /day was 2.4 to 4.4 times higher under drip fertigation based on pooled means, compared to rainfed control. Relative economic efficiency, (which is a measure of increase in net income over control) was worked out to be 223 to 425% over rainfed cultivation of cassava with soil application of fertilizers. Maximum productivity per day and profitability/ha/day were recorded by the application of 75 kg nitrogen and 125 kg potash through fertigation. In this experiment, cassava yielded two-three times more tuber yield under fertigation compared to soil application, which resulted in more gross and net income and B:C ratio, productivity and profitability (Fig.1).

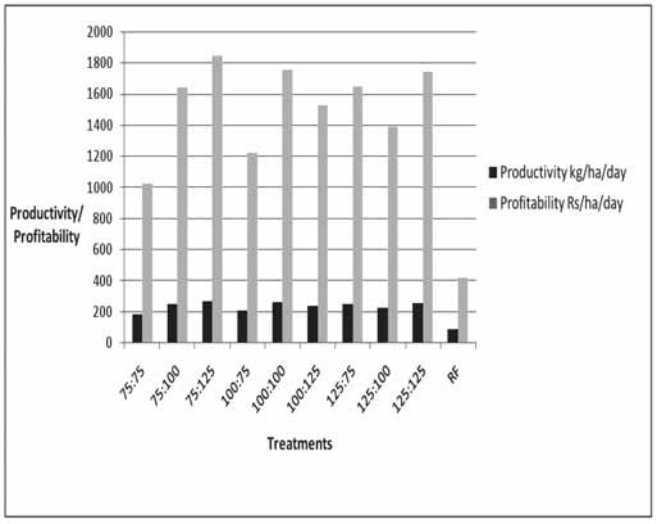

Fig. 1. Productivity and profitability of cassava /ha/day under drip fertigation and rainfed conditions

Conclusion

The above findings clearly revealed that cassava cultivation under drip fertigation is economical compared to rainfed cassava. Pooled mean of data over three years indicated that drip fertigation @ 75 kg nitrogen and 125 kg potash per ha through drip fertigation rseulted in maximum tuber yield, gross and net income, B:C ratio and profitability per ha per day in cassava.

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