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Study on the Economics of Banana Cultivation under Drip Fertigation

T. Basanta Singh[1*], S.K. Patra[1], K.H. Rishikanta Singh[2] and Chongtham Tania[2]

[1]Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, West Bengal, India
[2]ICAR Research Complex for NEH Region, Manipur Centre, Lamphelpat -795004, Imphal, India

**Corresponding author*

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A B S T R A C T

The field experiment was conducted at the Research Farm, BCKV, West Bengal to study the yield and economics for banana cultivation with drip fertigation. The drip fertigation was done at four evapotranspiration (ET) based irrigation levels (D_1=0.6 ET, D_2=0.8 ET, D_3=1.0 ET for drip and surface irrigation (S) at IW/CPE 1.0) and at three fertilizer levels of recommended doses of fertilizer (RDF) viz., F_1=60% RDF, F_2=80% RDF and F_3=100% RDF laid out in factorial randomized block design with three replications. The benefit-cost ratio (BCR) was found to be highest for D_2F_2 (4.42) followed by D_2F_3 (4.28) and D_2F_3 (4.28) and the lowest for conventional method of surface irrigation and soil fertilization (2.48 to 3.40). However, drip fertigation at 80 per cent of evapotranspiration supplemented with 80% RDF (D_2F_2) was observed to be the best option for optimum utilization of fertilizer nutrients and water for ensuring higher crop productivity and profitability in banana.

Introduction

Banana is one of the leading fruit crop of India. In India, drip fertigation is extensively used in the banana cultivation. This micro-irrigation system also allows clean and mechanized cultivation, thereby substantially reducing the cost of weeding. The potential for drip irrigation system in India is estimated to be around 21.3 M ha (Narayanamoorthy, 2008). But till the year 2010, we could achieve 1.9 m ha only under drip (4.9 M ha in micro irrigation). It has been accepted as the best solution for intensive crop production (Samuel *et al.,* 2002) and maintenance of economic viability through increased water use efficiency and water saving (Narayanamoorthy, 2006). The farmers in India generally follow conventional surface method of irrigation in banana cultivation which is quite inefficient and non-remunerative. The major portion of cost is incurred in hiring labour for irrigation (More *et al.,* 2005) and the drip fertigation system has been reported to reduce the labour costs by 30-35% (Berad *et al.,* 1999). The water saving, increase in productivity and gross income due to drip over the conventional flood method of irrigation in banana may be 29 percent, 29.1 percent and 30.2 percent,

respectively with a BCR of 2.3 (Narayanamoorthy, 2003). The Horticulture Mission Project under the Government of India in collaboration with the state governments has implemented and adopted the exclusive programme of micro-irrigation with the subsidy to the extent of 50 percent, but many states are lagging behind on large scale implementation. Hence, there is need to encourage farmers to adopt the drip irrigation method, even the initial capital is high but labour saving at long run. The banana farmers are being constrained with technical expertise to adopt drip irrigation system otherwise the investment in the drip system may not yield a result. It has been observed that the investments in drip fertigation for sugarcane, banana and grape cultivation, the BCR with different discount rates remain economically viable. But, the banana farmers are being constrained with technical expertise to adopt drip irrigation system. Therefore, we have a great scope for experimentation, economic evaluation for drip fertigation practice in banana cultivation to give clear picture to the farmers.

Materials and Methods

The field experiment was conducted during the year 2012 and 2013 at the Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya West Bengal encompassing the New Alluvial Zone (9.75 m above MSL and 23^{o} N and 89^{o} E coordinate). Healthy sword suckers (2-3 leaf) weighing around 1.5-2 kg each (2.0-2.5 month old) of banana cv. Martaman (AAB group) were planted (spacing = 2m × 2m) in the square pattern. The ratoon was maintained by retaining only one sucker per plant. The reference crop evapotranspiration (ETo) was taken as the basis to calculate of crop water requirement (Doorenbos and Pruitt, 1977). The volume of water required per plot was computed based on the equation given by Vermeiren and Jobling (1980). The drip fertigation was done at four evapotranspiration (ET) based irrigation levels (D_1=0.6 ET, D_2=0.8 ET, D_3=1.0 ET for drip and surface irrigation (S) at IW/CPE 1.0) and at three fertilizer levels of recommended doses of fertilizer (RDF) viz., F_1=60% RDF, F_2=80% RDF and F_3=100% RDF laid out in factorial randomized block design with three replications. In case of surface irrigation, water was applied at irrigation water (IW) divided by Cumulative pan evaporation (IW/CPE) equal to 1.0 which is scheduled at 15-20 days' interval. The water soluble and cheaply available conventional fertilizers were used for the fertigation.

Economic analysis

The economic analysis was carried out to determine the economic feasibility of the crop under standard drip fertigation *vis-à-vis* the surface irrigation with conventional soil fertilization assuming that the gravity drip gives approximately similar yield with the standard one. For the economic analysis (per hectare basis), total cost of cultivation, gross returns and net returns were calculated from the yield of banana (2500 plants/ha). The seasonal cost of drip irrigation system and 4 Horse Power water pump includes 4percent depreciation, prevailing 10 percent interest rate, 2 percent interest for repair and maintenance cost calculated from the fixed cost. The life span of the drip irrigation system was considered to be 10 years. The total cost of cultivation for drip and surface irrigations was calculated by considering the cost incurred in land preparation, intercultural operation, fertilizer, crop protection measures, irrigation water and harvesting during the period of experimentation. Gross return from each treatment was calculated from the yield of banana by accounting the prevailing market price during the harvesting periods. Net returns were calculated by subtracting the total

cost of cultivation from the gross return. The benefit cost ratio (BCR) was calculated by dividing the gross returns of each treatment with their respective cost of cultivations.

Results and Discussion

The economics of the drip fertigation systems was worked out to determine the economic feasibility and benefit-cost ratio of the system by considering the cost of standard drip fertigation *vis-à-vis* the surface irrigation with soil fertilization assuming that the gravity drip delivers approximately similar yield with the standard one. The seasonal system cost of drip irrigation system incorporates depreciation, prevailing bank interest rate and repair and maintenance cost of the system. The depreciation was taken as 4 percent, the interest rate as 10 percent and repair as well as maintenance cost of the system as 2 percent per annum of the fixed cost.

The usual life span of the drip system was considered to be 10 years. The operating cost of cultivation accommodated expenses incurred in land preparation and planting, intercultural operation, fertilizers, crop protection measures, irrigation water and harvesting with labour charges. The total cost of banana cultivation was determined by adding the fixed cost and operating cost of cultivation including the different treatments cost. The estimated seasonal cost of cultivation excluding the variable cost of fertilizers and irrigation was observed to be Rs. 82,500 for the drip irrigation system and Rs. 76,500 for the surface irrigation system (Table 1). The total average volume of water required to irrigate 1.0 ha of banana field constituting 2500 plants (2m x 2m) through drip irrigation system was found to be 2386.2 m^3 for 0.6 ETo, 3181.6 m^3 for 0.8 ETo and 3977.0 m^3 for 1.0 ETo considering 90 percent irrigation efficiency and 9600.0 m^3 for surface irrigation system at IW/CPE 1.0 considering 75 percent irrigation efficiency. The treatment costs of irrigation and fertilizer for drip fertigation ranged between Rs. 17,663 to Rs. 29,438/ha/year and Rs. 23,675 to Rs. 34,124/ha/year for surface irrigation plus soil fertilization (Table 2).

The gross return of each treatment was calculated by multiplying the yield of banana with the prevailing market price @ Rs. 11/kg during the harvesting periods *i.e.*, March and April of 2012 and 2013 (Table 3). Gross return was observed to be the highest for the treatment combination D_3F_3 (Rs. 478958/ha/year), followed by the treatment combination D_2F_3 (Rs. 475750/ha/year) and D_2F_2 (Rs. 468875/ha/year). However, the lowest gross return of Rs. 248417/ha/year was obtained from surface irrigation supplemented with 60% of RDF (SF_1). It was also observed that the net return from drip system at varying levels of irrigation and fertigation was found to be higher in all cases than the surface method of irrigation except for D_1F_1 treatment.

Out of the different drip fertigation treatments, drip irrigation at 1.0 ETo with 100% RDF (D_3F_3) recorded the highest net profit (Rs. 367,020/ha/year), immediately followed by that of drip irrigation at 0.80 ETo with 100% RDF (D_2F_3) exhibiting Rs. 364,474/ha/year and drip irrigation at 0.80 ETo with 80% RDF (D_2F_2) showing a net profit of Rs. 362,842 /ha/year.

The BCR or return per rupee investment was found to be higher in drip fertigation treatments than that of conventional surface irrigation system (Table 3). The highest BCR was recorded for the treatment combination D_2F_2 (4.42) followed by D_2F_3 (4.28), D_3F_3 (4.28) and D_3F_2 (4.20) and for conventional method (2.48 to 3.40). The higher BCR in the drip fertigation was the consequences of the reduction of cost on irrigation and labour.

Table.1 Fixed and operation cost of banana cultivation for one hectare of land under drip fertigation and surface irrigation systems (excluding fertilizer and irrigation cost)

Sl. No.	Particular	Drip fertigation	Surface irrigation
Fixed cost			
1	Installation cost including one 4 HP water pump (Rs. 20,000)	1,00000	-
2	Life span for drip system and water pump (year)	10	-
3	Depreciation @ 4% (Rs.)	4,000	-
4	Interest cost @ 10% (Rs.)	10,000	-
Operating cost (excluding fertilizers and irrigation cost)			
5	Repair and maintenance cost including electrical and labour charge @ 2% (Rs.)	2000	-
6	Seasonal cost of drip system (3+4+5) (Rs.)	16,000	-
7	Cost for field preparation and planting (Rs.)	30,000	30,000
8	Cost for cultural practices (Rs.)	25,000	35,000
9	Cost for plant protection measures *i.e.*, chemicals + application charges (Rs.)	6,500	6,500
10	Labour cost incurred during harvesting @ Rs. 2/bunch	5,000	5,000
	Seasonal total cost (6 + 7 + 8 +9 + 10)	Rs. 82,500	Rs. 76,500
Note: Land tax is considered negligible			

Table.2 Details of treatment cost for fertilizers and irrigation for cultivating one hectare of banana

Treatments	N:P:K (g/plant/year)	Amounts of Urea: DAP: MOP (kg/ha/season)	Total cost of fertilizer (Rs.)*	Total volume of water (L)	Volume of water/season (L)	Pump operation (hrs)	Consumption of diesel (L)†	Cost of diesel/ season (Rs.)‡	Total cost (Rs.)
D_1F_1	120:30:150	588:163:625	15675	4,772,347	2,386,173	88.4	44.2	1,988	17,663
D_1F_2	160:40:200	784:217:833	20899	4,772,347	2,386,173	88.4	44.2	1,988	22,888
D_1F_3	200:50:250	981:272:1042	26124	4,772,347	2,386,173	88.4	44.2	1,988	28,113
D_2F_1	120:30:150	588:163:625	15675	6,363,129	3,181,564	117.8	58.9	2,651	18,326
D_2F_2	160:40:200	784:217:833	20899	6,363,129	3,181,564	117.8	58.9	2,651	23,551
D_2F_3	200:50:250	981:272:1042	26124	6,363,129	3,181,564	117.8	58.9	2,651	28,776
D_3F_1	120:30:150	588:163:625	15675	7,953,911	3,976,956	147.3	73.6	3,314	18,989
D_3F_2	160:40:200	784:217:833	20899	7,953,911	3,976,956	147.3	73.6	3,314	24,214
D_3F_3	200:50:250	981:272:1042	26124	7,953,911	3,976,956	147.3	73.6	3,314	29,438
SF_1	120:30:150	588:163:625	15675	19,200,000	9,600,000	355.6	177.8	8,000	23,675
SF_2	160:40:200	784:217:833	20899	19,200,000	9,600,000	355.6	177.8	8,000	28,899
SF_3	200:50:250	981:272:1042	26124	19,200,000	9,600,000	355.6	177.8	8,000	34,124

***Cost per kg of urea: Rs. 6.5, DAP: Rs. 18.0,MOP: Rs. 14.0/kg,**
†Diesel consumption @ 0.5 Lph with discharge rate =15 Lps
‡Cost of diesel Rs. 45/L

Table.3 Economic analysis of different treatment combinations in banana cultivation for one hectare of land

Treatments	Fixed and operating cost of cultivation (Rs. /ha)†	Fertilizers and irrigation cost (Rs. /ha)	Seasonal total cost of Cultivation (Rs. /ha)	Yield (t/ha)	Gross returns (Rs. /ha)*	Net returns (Rs. /ha)	Benefit cost ratio (BCR)
D_1F_1	82,500	17,663	100,163	28.2	310,292	210,129	3.10
D_1F_2	82,500	22,888	105,388	35.5	390,042	284,654	3.70
D_1F_3	82,500	28,113	110,613	38.3	421,667	311,054	3.81
D_2F_1	82,500	18,326	100,826	34.8	382,250	281,424	3.79
D_2F_2	82,500	23,551	106,051	42.6	468,875	362,824	4.42
D_2F_3	82,500	28,776	111,276	43.3	475,750	364,474	4.28
D_3F_1	82,500	18,989	101,489	38.0	417,542	316,053	4.11
D_3F_2	82,500	24,214	106,714	40.8	448,708	341,995	4.20
D_3F_3	82,500	29,438	111,938	43.5	478,958	367,020	4.28
SF_1	76,500	23,675	100,175	22.6	248,417	148,242	2.48
SF_2	76,500	28,899	105,399	30.3	332,750	227,351	3.16
SF_3	76,500	34,124	110,624	34.2	375,833	265,209	3.40

†Excluding the fertilizers and irrigation cost
***Market price of banana: Rs. 11 /kg during March 2012 and March 2013 (average)**

Similar findings have been reported by Chandrakumar *et al.,* (2001) who recorded the highest BCR was with 150 g/plant/year of N and K fertigation in banana. The BCR of 5.26 has been demonstrated from drip fertigation of banana in Bhawansinagar, Gujarat (AICRP-WM, 2010). More *et al.,* (2005) demonstrated that the major portion of human labour was chiefly used for irrigating the crop leading to the reduction of BCR which was drastically curtailed in drip irrigation system. Increased income in banana crop through drip irrigation has also been reported earlier (Agrawal and Agrawal, 2005; Shashidhara *et al.,* 2007). Based on the higher average WUE (55.7 kg/ha-mm), average water saving (49.8%) and a higher estimated BCR (4.42), the drip irrigation at 80% evapotranspiration replenishment (0.8 ETo) equivalent to 3181.5 m^3/ha/year or 1272.6 litre/plant/year supplemented with 80% RDF (N:P:K =160:40:200 g/plant/year) can be advocated to the farmers of Gangetic plain of India.

From the results of the study, it can be concluded that, drip irrigation is by far the most advantageous over conventional surface irrigation in economizing water use in terms of higher water use efficiency and considerable water savings with higher yield of banana. Though the initial investment for laying the drip fertigation system is high and an impediment for resource poor farmers, however, its long-term benefits can be accrued by increasing the monetary returns and hence improving the better economy of small and marginal farmers. Farmers can opt for low cost and easily available fertilizers like urea, DAP, and MOP. The future of the banana cultivation practice in 21st century lies in the use of fertigation method through drip irrigation.

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