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ORIGINAL ARTICLES

Effect of different levels of planting distances, irrigation and fertigation on yield characters of main banana crop cv. Grand Naine

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ABSTRACT

An investigation was carried out in planted banana crop cv. Grand Naine (*Musa* AAA) to evaluate the effect of three planting distances with 3 levels of irrigation through drip and 3 fertigation levels which were laid out in a split-split plot design with four replications on yield parameters of the main banana crop. Plants grown under the widest planting distance (1.75 x 1.75 m) recorded increase in bunch weight and number of fingers per hand. The maximum number of fingers per hand, per bunch and yield per hectare were found at I_1 irrigation level of 764.26 mm per year. Reduction in fertigation dose resulted in the deterioration of bunch characters. The highest bunch weight (37.67 kg/plant) was registered at D_1 x I_2 x F_1 combinations. However, the combination D_1 x I_1 x F_3 was more economical and at par with that of superior combinations. The result indicated that the main crop grown at 1.75 x 1.75 m planting distance with irrigation level 40 per cent PE (764.26 mm per year) and 80 per cent of the recommended fertilizer dose (160 N : 32 P_2O_5 : 192 K_2O g per plant per year) improved yield attribute characters and maintained higher benefit /cost ratio over the other treatments. The Main crop grown under different drip and fertigation treatment combinations were superior to the crop grown under the control treatment by using surface irrigation and conventional application of solid fertilizers as regards to most yield attribute characters.

Key words: Banana, Fertigation, Irrigation, Planting distances, Yield Characters.

Introduction

In India and abroad, research work on planting densities generally with reduced spacing in banana has been attempted with varying success. Increased yield without detriment to quality has been witnessed under high density planting of banana The HDP has been successfully implicated in fruit crops such as banana (Reddy and Singh, 1993; Manivannan, 1994; Krishnakumary *et al*., 1995). There was reduction in water and fertilizers to a tune of 30-40 per cent, pronounced extension of crop duration beside appreciable increase in productivity per unit area has been reported under HDP. Reduction in individual bunch weight than normal planting, and slight reduction in quality parameters has been observed by some research workers (Apshara, 1997; Nalina, 2000; Mahalakshmi, 2000).

In banana cv. Robusta Mandal and Sharma (1999) reported that plant height, days required from flowering to fruit maturity and fruit yield were significantly increased in crop density. However, high density of 1600 and 2000 plant/ha resulted in a decrease in the number of fruits, number of hands per bunch, fruit weight and bunch weight. Nalina *et al*. (2000) studied influence of reduced NPK fertilizer application under high density planting in banana cv. Robusta (AAA) involving three to four suckers per hill. With reduced fertilizer rates, significant reduction in bunch character namely, finger weight, finger length, finger circumference and pulp- peel ratio were noted in all HDP treatments compared to the control. Fifty per cent of the recommended fertilizer rate resulted in more bunch and finger weight. With a decrease in nutrient level, there was a corresponding reduction in total soluble solids, ascorbic acid, reducing and non-reducing sugars and sugars acidity ratio. Apshara *et al*. (2001) also reported that in banana cv. Nendran (AAB), The total yields were higher in the high density treatments than those in the wider spacing.

Banana plantation in tropics can consume 900 to 1800 mm water from planting to harvest (Stover and Simmonds, 1987) and the water requirement of banana outside the tropics should be met from supplementary irrigation. Hegde (1993) reported that in banana cultivar Robusta, Pseudostem height and girth was significantly less with 120 mm CPE irrigation regime compared to 20,40 and 60 mm CPE regimes. Frequent irrigation resulted in significantly early flowering. Irrigation at 60 mm CPE gave the best results. Highest and significant increase in the bunch yield (55.06 t/ha) was recorded with normal planting at 1.0 ETc over rest of the combinations. Under adequate water availability with normal planting drip saved 24.2 per cent water and

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increased yield by 13.4 per cent over control. Beside water saving and increased yield with drip irrigation, less crop duration to the extent of 20 per cent was noticed as compared to conventional surface irrigation.

Drip irrigation is a very efficient method supplying water to plant precisely very close to the root zone. There is a scarcity of information regarding the optimum water requirements of banana (*Musa acuminate* AAA group) grown under semiarid conditions with drip irrigation in the tropics. Geonaga and Irizarry, (1995) reported that marketable yield was higher 86.3 kg/ha from the R2 crop with irrigation at a pan factor of 1.25. main crop and R1 plants irrigated using the same pan factor yielded 45.3 and 70.3 kg/ha, respectively. Increasing the pan factor from 0.25 to 1.25 resulted in weight gains of the third-upper hand of 70 per cent in parent plants, 90 Per cent in R1 and 122 Per cent in R2. Irrigation according to increasing pan factors resulted in significant increase in the number of hands per bunch and length and diameter of fruits . banana grown under semiarid conditions should be irrigated with a pan factor of 1.0.

Hegde and Srinivas (l992) compared the growth, productivity, nutrient uptake and water use of bananas under drip and basin systems of irrigation with three levels of N and K each at 100, 200 and 300 g/plant. Plants under drip irrigation had better growth, flowered earlier, accumulated more organic matter and nutrients and produced higher yield with increased water use efficiency. Fruit quality was not affected by irrigation

To achieve maximum water use efficiency, Shemueli (1953) reported that 66 per cent of available soil moisture level was sufficient. According to. Krishnan and Shanmugavelu (1980) opined that 60-80 per cent of available soil moisture level was sufficient to fulfill water requirement of banana.

Application of fertilizers along with irrigation (fertigation) makes it easy to match nutrients application with plant growth. This is particularly important for high density planting which must maximize early growth and yield. Since the nutrients are applied to a limited soil area, fertilizer use efficiency can be improved relative to conventional application methods. Beside, economizing the water and fertilizer, it also saves labour towards weeding, fertilizer application and irrigation.

Banana being a voracious feeder of water and nutrients, the crop is highly amenable for fertigation technique. Lahav and Kalmar (1988) opined that banana responded well to drip fertigation in Israel. Guerrero and Gadbau (1996) observed high yield of banana (45-60 t/ha) in Columbia (tropical conditions) under fertigation and high density planting (1200-1800 t/ha). Smith (1991) reported high yield (45-60 t/ha) from high density planting (2000 plants/ha) combined with fertigation in Canary Islands under subtropical conditions.

Commercial banana plantations are now being irrigated through drip in India largely due to dwindling water resources and receding water table. Many changes have occurred in fertigation practices with adoption of drip irrigation. The rate of nutrient application has also changed with shortening of irrigation and fertilization interval. By adopting fertigation and narrow planting density (2500 plant per ha) Mahalakshmi (2000) reported high yield (85.22 t/ha).Under high density planting higher yield (148.60 t /ha) was obtained.

The normal planting distance or (1.8 x 1.5 m) with recommended dose of 100:40:200 g NPK per plant in solid form; and only nitrogen in (Urea) form through drip performed well in respect of all yield attributes and registered 15 Per cent more yield (68.5 t/ha) and 7 per cent more net returns (Rs.109130/ha) as compared to surface irrigation with same planting technique and fertilizer dose. Use of liquid fertilizer registered 25 Per cent saving in fertilizers as compared to solid one, but high cost (about 3.5 times) of liquid fertilizers over solid has significantly lessened their economic viability substantially. Normal planting was proved better by increasing yield (8%) and monetary returns (13%) over paired planting (0.9 m- 2.7 x 1.5 m), but never the less paired planting reduced drip system cost by 30 Per cent, labour cost by 15 to 20 Per cent and allowed mechanized and easy cultivation. Drip method of irrigation was found to be efficient with 47.88 per cent saving in water and 30-35 per cent saving in labour (Berad *et al*., 1998).

Material And Methods

The experiment was conducted during 2003-2005 at Precision Farming Development Centre, Dr. Annasaheb Shinde College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri, India. The experiment was laid out in split-split plot design, with 27 treatment combinations besides control (Table 2), replicated thrice with three plants in each replication. Guard rows were provided on all sides of the plots.

Treatment details:

I) **Main factors** : 3 levels of planting distances (D):

D_1	1.75 x 1.75 m	(3265 plants/ha)
D_2	1.5 x 1.5 m	(4444 plants/ha)
D_3	1.25 x 1.25 m	(6400 plants/ha)

II) **Sub factors** : 3 levels of irrigation through drip (I):

Main crop	**Ratoon crop**

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I_1	40% PE	(764.26 mm per year)	(791.33 mm per year)
I_2	60% PE	(1146.40 mm per year)	(1186.99 mm per year)
I_3	80% PE	(1528.53 mm per year)	(1582.66 mm per year)
Control	(2460 mm per year)	(2520 mm per year)	

III) Sub-sub factors :3 levels of water soluble NPK fertilizers through drip (F):

F_1 120 % RDF (240 N : 48 P : 288 K g/plant/year)
F_2 100 % RDF (200 N : 40 P : 240 K g/plant/year)
F_3 80 % RDF (160 N : 32 P : 192 K g/plant/year)

iv) Control: Consisted of 1.5 x 1.5 m planting distance (4444 plants/ha), surface method of irrigation and application of recommended dose of fertilizers (RDF) in solid form.

The soil of the experimental plots was prepared to a fine tilth by cross wise ploughing followed by harrowing with disk harrow. Field was made free from organic residues of the previous crop or weed .Furrow then irrigated and farm yard manure (FYM) 10 kg was mixed for each hill .Tissue cultured plants of banana cv. Grand Naine were used as planting material. Banana planting was done on 31 July, 2003 and there after recommended package of cultural practices were followed. The special horticulture practices viz., earthing up, desuckering, propping removal of floral buds etc. were carried out as usual. Drip and surface irrigation was scheduled on the basis of pan evaporation (PE) .The time of operation of drip irrigation system was decided by knowing the average discharge of microtube per plant.

Two types of fertilizers i.e., normal solid fertilizers and water soluble fertilizers were used .The recommended fertilizer dose(R F D) of solid fertilizers (200N: 40 P2O5 : 240 K2O g per plant per year) was applied for control treatment by ring method .Out of 25 per cent N through organic fertilizers (10 kg FYM at the time of planting and 75 per cent through inorganic fertilizers in four equal split doses at 45,90 and 210 days after planting .Phosphorus 40 g per plant was applied at the time of planting and 240 g K2O was applied in four equal split doses at the time of planting 165, 255 and 300 days after planting .Fertilizers for the treatment combinations were applied through drip irrigation system (fertigation).Weighed quantity of water soluble fertilizers and urea was added in water and injected in the lateral line as per treatments. Application of water soluble fertilizer through drip irrigation system was scheduled at monthly intervals spread over a period of 10 months, starting from one month after setting of suckers. The following fertilizers grades were used during experimentation (Table1). Nine plants were selected randomly in each treatment for recording the growth characters. The bunch characters were recorded during main crop trials from randomly selected plants and the mean values were computed. Weight of bunch was recorded including the peduncle measuring 20 cm above the first hand and expressed in kilograms.

Number of fingers per hand and total number of fingers per bunch were counted and expressed in number.

Result And Discussion

From these experimental results, the benefit cost ratio study revealed that D_1 x I_1 x F_3 and D_1 x I_2 x F_3 treatment combination are found to be optimum and economical combination of planting distance, irrigation level and fertigation level for main and ratoon crops, respectively (Table 4, 5), however, relatively less number of fingers per hand and per bunch beside low yield per hectare were obtained under that combination.

The result also revealed that D_2 x I_2 x F_2 treatment combination during ratoon crop duration showed the highest benefit cost ratio, and required higher fertilizer dose (100% of the recommended dose). The treatment combination D_1 x I_2 x F_3 saved 20% of fertilizer recommended dose, and reported relatively higher benefit cost ratio (1.51) (Table 5).

From these experimental results, it appears that there is improvement in bunch characters performance in both main and ratoon crop grown under treatment combinations (using drip and fertigation system) as compared to that crops grown under control treatment (using surface irrigation and conventional application of solid fertilizers) (table 2&3). This result agree with Mahalakshmi (2000) who reported that the application of drip and fertigation system was found to be appropriate in inducing higher bunch weight and more number of fingers per hand per bunch.

Drip irrigation in general increased the yield of banana parallel with saving water (Hegde and Srinivas,1990; Santhana Bosu *et al*., 1995; Upadhyay, 1995; Mahalakshmi, 2000). Cevik *et al*. (1985) also reported that drip irrigation used fifty per cent less water than surface irrigation. Moreover, drip irrigated plants produced higher yield than surface irrigated plants.

Table 1: Fertilizers grades used during experimentation

Fertilizer grade	Type of Fertilizer	Nutrient levels N:P:K	Purpose
Urea NH2_CO_NH2	N S F	46 : 0 :0	For full nitrogen requirement
Single superphosphate P2O5	N S F	0 : 16 : 0	For full phosphorus
Muriate of potash KCl	N S F	0 : 0 : 60	For full potassium requirement
NPK	W S F	19 : 19 : 19	For full P and part of N and K requirement
Urea	W S F	46 : 0 : 0	To cater remaining N left out.
K	W S F	0 : 0 : 50	To cater remaining K left out.

WSF,Water-soluble fertilizer NSF,Normal solid fertil

Table 2: Influence of planting distance, irrigation and fertigation levels interactions on bunch characters of main crop

Treatment	Bunch weight (kg/plant)	Fingers/ hand	Fingers/ bunch	Yield (t/ha)
Planting distance, irrigation and fertigation levels interactions (AxBxC)				
D_1 x I_1 x F_1	25.14^{j}	19.44^{a}	138.10^{g}	82.10^{l}
D_1 x I_1 x F_2	37.33^{ab}	18.22^{bc}	170.00^{abc}	121.90^{fghij}
D_1 x I_1 x F_3	34.78^{abcde}	17.56^{cdefg}	159.00^{cdef}	113.60^{ghijk}
D_1 x I_2 x F_1	37.67^{a}	18.11^{bcd}	163.60^{bcde}	123.00^{fghij}
D_1 x I_2 x F_2	28.55^{hij}	18.89^{ab}	145.90^{fg}	93.24^{kl}
D_1 x I_2 x F_3	$31.51^{cdefghi}$	17.22^{cdefgh}	151.70^{defg}	102.90^{ijkl}
D_1 x I_3 x F_1	36.00^{abc}	17.22^{cdefgh}	149.40^{efg}	117.50^{fghij}
D_1 x I_3 x F_2	$33.78^{abcdefg}$	17.22^{cdefgh}	160.40^{cdef}	110.30^{hijk}
D_1 x I_3 x F_3	$32.67^{bcdefgh}$	17.11^{cdefgh}	158.40^{cdef}	106.70^{ijk}
D_2 x I_1 x F_1	$33.12^{abcdefgh}$	16.89^{efghi}	178.10^{ab}	148.60^{e}
D_2 x I_1 x F_2	$33.11^{abcdefgh}$	17.11^{cdefgh}	181.80^{a}	140.70^{ef}
D_2 x I_1 x F_3	29.33^{fghij}	17.44^{cdefg}	161.70^{cdef}	132.30^{efgh}
D_2 x I_2 x F_1	29.00^{fghij}	16.56^{fghij}	151.6^{defg}	128.9^{efghi}
D_2 x I_2 x F_2	30.89^{defghi}	16.22^{hij}	163.70^{bcde}	134.30^{efgh}
D_2 x I_2 x F_3	30.00^{efghij}	18.00^{bcde}	166.60^{bcd}	136.80^{efg}

Table 2: (Contd….)

Treatment	Bunch weight (kg/plant)	Fingers/ hand	Fingers/ bunch	Yield (t/ha)
Planting distance, irrigation and fertigation levels interactions (AxBxC)				
D_2 x I_3 x F_1	30.00^{efghij}	16.56^{fghij}	149.90^{efg}	138.70^{ef}
D_2 x I_3 x F_2	30.11^{efghij}	16.45^{ghij}	164.10^{bcde}	131.30^{efgh}
D_2 x I_3 x F_3	29.78^{efghij}	16.55^{fghij}	159.40^{cdef}	133.80^{efgh}
D_3 x I_1 x F_1	35.82^{abcd}	16.56^{fghij}	163.10^{bcde}	229.30^{a}
D_3 x I_1 x F_2	27.27^{ij}	17.66^{cdef}	160.30^{cdef}	174.50^{d}
D_3 x I_1 x F_3	$31.49^{cdefghi}$	16.55^{fghij}	162.20^{bcdef}	201.50^{bc}
D_3 x I_2 x F_1	$32.74^{abcdefgh}$	18.22^{bc}	140.10^{g}	209.60^{ab}
D_3 x I_2 x F_2	28.49^{hij}	15.89^{ij}	161.20^{cdef}	182.30^{cd}
D_3 x I_2 x F_3	26.66^{ij}	17.11^{cdefgh}	140.70^{g}	170.70^{d}
D_3 x I_3 x F_1	34.00^{abcdef}	17.00^{defghi}	165.20^{bcde}	217.60^{ab}
D_3 x I_3 x F_2	28.89^{ghij}	15.55^{j}	161.20^{cdef}	184.90^{cd}
D_3 x I_3 x F_3	29.00^{fghij}	17.00^{defghi}	151.30^{defg}	185.60^{cd}
Control	24.81	15.39	133.03	118.34
SE ±	1.47	0.33	4.77	7.19
CD (0.05)	4.21	0.95	13.69	20.62
CV%	18.12	13.34	15.22	18.51

In each column means followed by different letters are significantly different at the 5% level using Duncan's Multiple Test.

Table 3: Influence of planting distance, irrigation and fertigation levels interactions on bunch characters of ratoon crop.

Treatment	Bunch weight (kg/plant)	Fingers / hand	Fingers / bunch	Yield (t/ha)
Planting distance, irrigation and fertigation levels interactions (AxBxC)				
D_1 x I_1 x F_1	23.92^{defgh}	18.44^{a}	114.70^{i}	78.11^{l}
D_1 x I_1 x F_2	27.89^{bcdef}	17.22^{bc}	149.60^{cdefg}	91.06^{jkl}
D_1 x I_1 x F_3	23.28^{fgh}	16.56^{cdefg}	$148.10^{bcdefgh}$	76.00^{l}
D_1 x I_2 x F_1	29.56^{bc}	17.11^{bcd}	163.70^{abc}	96.50^{hijkl}
D_1 x I_2 x F_2	23.45^{fgh}	17.89^{ab}	131.10^{fghi}	76.55^{l}
D_1 x I_2 x F_3	26.67^{bcdefg}	16.22^{cdefgh}	152.60^{bcdef}	87.07^{jkl}
D_1 x I_3 x F_1	28.56^{bcde}	16.22^{cdefgh}	178.40^{a}	93.24^{ijkl}
D_1 x I_3 x F_2	$26.34^{bcdefgh}$	16.22^{cdefgh}	164.20^{ab}	85.98^{kl}
D_1 x I_3 x F_3	23.67^{efgh}	16.11^{cdefgh}	$146.70^{bcdefgh}$	77.27^{l}
D_2 x I_1 x F_1	$26.11^{bcdefgh}$	15.89^{efghi}	160.80^{abcde}	115.50^{efghi}
D_2 x I_1 x F_2	27.22^{bcdefg}	16.11^{cdefgh}	154.40^{bcdef}	122.90^{efg}
D_2 x I_1 x F_3	24.55^{cdefgh}	16.44^{cdefg}	155.10^{bcdef}	109.60^{fghij}
D_2 x I_2 x F_1	26.55^{bcdefg}	15.56^{fghij}	135.40^{fghi}	117.00^{efgh}
D_2 x I_2 x F_2	34.00^{a}	15.22^{hij}	181.60^{a}	153.60^{bc}
D_2 x I_2 x F_3	23.89^{defgh}	17.00^{bcde}	138.90^{defgh}	106.70^{ghijk}

Table 3: (Contd…)

Treatment	Bunch weight (kg/plant)	Fingers / hand	Fingers /bunch	Yield (t/ha)
Planting distance, irrigation and fertigation levels interactions (AxBxC)				
D_2 x I_3 x F_1	23.00^{fgh}	15.56^{fghij}	148.10^{bcdefgh}	102.70^{ghijk}
D_2 x I_3 x F_2	29.67^{b}	15.45^{ghij}	154.30^{bcdef}	130.40^{def}
D_2 x I_3 x F_3	23.33^{fgh}	15.55^{fghij}	146.80^{bcdefgh}	108.60^{fghijk}
D_3 x I_1 x F_1	26.33^{bcdefgh}	15.56^{fghij}	162.30^{abcd}	168.50^{ab}
D_3 x I_1 x F_2	23.33^{fgh}	16.66^{cdef}	124.40^{hi}	149.30^{bcd}
D_3 x I_1 x F_3	23.44^{fgh}	15.55^{fghij}	145.20^{bcdefgh}	151.50^{bcd}
D_3 x I_2 x F_1	28.89^{bcd}	17.22^{bc}	136.40^{efghi}	184.60^{a}
D_3 x I_2 x F_2	21.44^{h}	14.89^{ij}	142.10^{bcdefgh}	138.00^{cde}
D_3 x I_2 x F_3	22.56^{gh}	16.11^{cdefgh}	127.80^{ghi}	145.10^{cd}
D_3 x I_3 x F_1	26.89^{bcdefg}	16.00^{defghi}	138.00^{defghi}	170.00^{ab}
D_3 x I_3 x F_2	26.22^{bcdefgh}	14.55^{j}	139.10^{cdefgh}	169.20^{ab}
D_3 x I_3 x F_3	27.67^{bcdef}	16.00^{defghi}	146.40^{bcdefgh}	184.40^{a}
Control	20.42	14.39	118.36	91.84
SE ±	1.46	0.33	7.17	7.05
CD (0.05)	4.21	0.95	20.59	20.23
CV%	19.83	13.54	18.42	10.03

In each column means followed by different letters are significantly different at the 5% level using Duncan's Multiple Test.

Table 4: Benefit /Cost of main banana crop production through fertigation under high density planting

Treatment	Drip system cost (Rs/ha)	Plants cost (Rs /ha)	Labour cost (Rs/ha)	Fertilizer cost (Rs/ha)	Irrigation water cost (Rs/ha)	Total cost (Rs /ha) (C)	Yield (t/ha)	Selling price (Rs/t)	Gross income (Rs/ha)	Net income (Rs/ha) (B)	B/C Ratio
D_1 x I_1 x F_1	16704	39180	12590	53022.45	1604.956	123101.41	82.10	3000	246300	123198.59	1.00
D_1 x I_1 x F_2	16704	39180	12590	44185.38	1604.956	114264.33	121.90	3000	365700	251435.67	2.20
D_1 x I_1 x F_3	16704	39180	12590	35348.30	1604.956	105427.26	113.60	3000	340800	235372.74	2.23
D_1 x I_2 x F_1	16704	39180	12590	53022.45	2407.434	123903.89	123.00	3000	369000	245096.11	1.98
D_1 x I_2 x F_2	16704	39180	12590	44185.38	2407.434	115066.81	93.24	3000	279720	164653.19	1.43
D_1 x I_2 x F_3	16704	39180	12590	35348.30	2407.434	106229.73	102.90	3000	308700	202470.27	1.91
D_1 x I_3 x F_1	16704	39180	12590	53022.45	3209.913	124706.36	117.50	3000	352500	227793.64	1.83
D_1 x I_3 x F_2	16704	39180	12590	44185.38	3209.913	115869.29	110.30	3000	330900	215030.71	1.86
D_1 x I_3 x F_3	16704	39180	12590	35348.30	3209.913	107032.21	106.70	3000	320100	213067.79	1.99
D_2 x I_1 x F_1	20383	53328	15019	72169.00	1604.953	162503.95	148.60	2800	416080	253576.05	1.56
D_2 x I_1 x F_2	20383	53328	15019	60140.83	1604.953	150475.78	140.70	2800	393960	243484.22	1.62
D_2 x I_1 x F_3	20383	53328	15019	48112.66	1604.953	138447.62	132.30	2800	370440	231992.38	1.68
D_2 x I_2 x F_1	20383	53328	15019	72169.00	2407.429	163306.42	128.90	2800	360920	197613.58	1.21
D_2 x I_2 x F_2	20383	53328	15019	60140.83	2407.429	151278.26	134.30	2800	376040	224761.74	1.49

Table 4: (Contd...)

Treatment	Drip system cost (Rs/ha)	Plants cost (Rs /ha)	Labour cost (Rs/ha)	Fertilizer cost (Rs/ha)	Irrigation water cost (Rs/ha)	Total cost (Rs /ha) (C)	Yield (t/ha)	Selling price (Rs/t)	Gross income (Rs/ha)	Net income (Rs/ha) (B)	B/C Ratio
D_2 x I_2 x F_3	20383	53328	15019	48112.66	2407.429	139250.09	136.80	2800	383040	243789.91	1.75
D_2 x I_3 x F_1	20383	53328	15019	72169.00	3209.906	164108.90	138.70	2800	388360	224251.10	1.37
D_2 x I_3 x F_2	20383	53328	15019	60140.83	3209.906	152080.74	131.30	2800	367640	215559.26	1.42
D_2 x I_3 x F_3	20383	53328	15019	48112.66	3209.906	140052.57	133.80	2800	374640	234587.43	1.67
D_3 x I_1 x F_1	25727	76800	18275	103933.75	1604.954	226340.70	229.30	2800	642040	415699.30	1.84
D_3 x I_1 x F_2	25727	76800	18275	86611.46	1604.954	209018.41	174.50	2800	488600	279581.59	1.34
D_3 x I_1 x F_3	25727	76800	18275	69289.16	1604.954	191696.12	201.50	2800	564200	372503.88	1.94
D_3 x I_2 x F_1	25727	76800	18275	103933.75	2407.432	227143.18	209.60	2800	586880	359736.82	1.58
D_3 x I_2 x F_2	25727	76800	18275	86611.46	2407.432	209820.89	182.30	2800	510440	300619.11	1.43
D_3 x I_2 x F_3	25727	76800	18275	69289.16	2407.432	192498.60	170.70	2800	477960	285461.40	1.48
D_3 x I_3 x F_1	25727	76800	18275	103933.75	3209.909	227945.66	217.60	2800	609280	381334.34	1.67
D_3 x I_3 x F_2	25727	76800	18275	86611.46	3209.909	210623.36	184.90	2800	517720	307096.64	1.46
D_3 x I_3 x F_3	25727	76800	18275	69289.16	3209.909	193301.07	185.60	2800	519680	326378.93	1.69
Control	-	53328	15019	60140.83	5137.41	133625.24	118.34	2800	331352	197726.76	1.48

Table 5: Benefit /Cost of ratoon banana crop production through fertigation under high density planting

Treatment	Drip system cost (Rs/ha)	Plants cost (Rs/ha)	Labour cost (Rs/ha)	Fertilizer cost (Rs/ha)	Irrigation water cost (Rs/ha)	Total cost (Rs /ha) (C)	Yield (t/ha)	Selling price (Rs/t)	Gross income (Rs/ha)	Net income (Rs/ha) (B)	B/C Ratio
D_1 x I_1 x F_1	16704	39180	12590	53022.45	1661.791	123158.24	78.11	3000	234330	111171.76	0.90
D_1 x I_1 x F_2	16704	39180	12590	44185.38	1661.791	114321.17	91.06	3000	273180	158858.83	1.39
D_1 x I_1 x F_3	16704	39180	12590	35348.30	1661.791	105484.09	76.00	3000	228000	122515.91	1.16
D_1 x I_2 x F_1	16704	39180	12590	53022.45	2492.686	123989.14	96.50	3000	289500	165510.86	1.34
D_1 x I_2 x F_2	16704	39180	12590	44185.38	2492.686	115152.06	76.55	3000	229650	114497.94	0.99

D_1 x I_2 x F_3	16704	39180	12590	35348.30	2492.686	106314.99	87.07	3000	261210	154895.01	1.55
D_1 x I_3 x F_1	16704	39180	12590	53022.45	3323.582	124820.03	93.24	3000	279720	154899.97	1.24
D_1 x I_3 x F_2	16704	39180	12590	44185.38	3323.582	115982.96	85.98	3000	257940	141957.04	1.22
D_1 x I_3 x F_3	16704	39180	12590	35348.30	3323.582	107145.88	77.27	3000	231810	124664.12	1.16
D_2 x I_1 x F_1	20383	53328	15019	72169.00	1661.787	162560.78	115.50	2800	323400	160839.22	0.99
D_2 x I_1 x F_2	20383	53328	15019	60140.83	1661.787	150532.62	122.90	2800	344120	193587.38	1.29
D_2 x I_1 x F_3	20383	53328	15019	48112.66	1661.787	138504.45	109.60	2800	306880	168375.55	1.22
D_2 x I_2 x F_1	20383	53328	15019	72169.00	2492.681	163391.68	117.00	2800	327600	164208.32	1.01
D_2 x I_2 x F_2	20383	53328	15019	60140.83	2492.681	151363.51	153.60	2800	430080	278716.49	1.84

Table 6.7: (Contd...)

Treatment	Drip system cost (Rs/ha)	Plants cost (Rs/ha)	Labour cost (Rs/ha)	Fertilizer cost (Rs/ha)	Irrigation water cost (Rs/ha)	Total cost (Rs /ha) (C)	Yield (t/ha)	Selling price (Rs/t)	Gross income (Rs/ha)	Net income (Rs/ha) (B)	B/C Ratio
D_2 x I_2 x F_3	20383	53328	15019	48112.66	2492.681	139335.34	106.70	2800	298760	159424.66	1.14
D_2 x I_3 x F_1	20383	53328	15019	72169.00	3323.574	164222.57	102.70	2800	287560	123337.43	0.75
D_2 x I_3 x F_2	20383	53328	15019	60140.83	3323.574	152194.40	130.40	2800	365120	212925.60	1.40
D_2 x I_3 x F_3	20383	53328	15019	48112.66	3323.574	140166.24	108.60	2800	304080	163913.76	1.17
D_3 x I_1 x F_1	25727	76800	18275	103933.75	1661.789	226397.54	168.50	2800	471800	245402.46	1.08
D_3 x I_1 x F_2	25727	76800	18275	86611.46	1661.789	209075.24	149.30	2800	418040	208964.76	0.99
D_3 x I_1 x F_3	25727	76800	18275	69289.16	1661.789	191752.95	151.50	2800	424200	232447.05	1.21
D_3 x I_2 x F_1	25727	76800	18275	103933.75	2492.683	227228.43	184.60	2800	516880	289651.57	1.28
D_3 x I_2 x F_2	25727	76800	18275	86611.46	2492.683	209906.14	138.00	2800	386400	176493.86	0.84
D_3 x I_2 x F_3	25727	76800	18275	69289.16	2492.683	192583.85	145.10	2800	406280	213696.15	1.11
D_3 x I_3 x F_1	25727	76800	18275	103933.75	3323.578	228059.32	170.00	2800	476000	247940.68	1.09
D_3 x I_3 x F_2	25727	76800	18275	86611.46	3323.578	210737.03	169.20	2800	473760	263022.97	1.25
D_3 x I_3 x F_3	25727	76800	18275	69289.16	3323.578	193414.74	184.40	2800	516320	322905.26	1.67
Control	-	53328	15019	60140.83	5137.41	133625.24	91.84	2800	257152	123526.76	0.92

Conclusion:

To sum up, it can be concluded that when main crop is grown at wider planting distance of 1.75 x 1.75 m and irrigated at 764.26 mm per year per plant combined with fertigation level of 160 N : 32 P_2O_5 : 192 K_2O g per plant per year recorded heavier bunch weight and higher yield t/ha. Based on the analysis of benefit /cost ratio, the combinations D_1 x I_1 x F_3 was found to be optimum and economical treatment combinations with respect to planting distance, irrigation and fertigation levels for main banana crop.

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