

EFFECT OF FERTIGATION ON YIELD, QUALITY AND NUTRIENT UPTAKE OF SUGARCANE

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By

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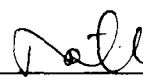
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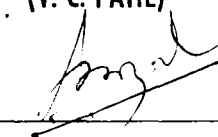
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Introduction

I. INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is one of the important commercial crops of the tropical countries and is the main source of sugar in the world. Globally, sugarcane is cultivated over an area of 19.40 million hectares with production of 1274 million tonnes and productivity of 65.69 tonnes per hectare (Anon., 2001).

India is one of the leading countries in sugarcane cultivation which is cultivated over an area of 4.33 million hectares with annual production of 299 million tonnes of cane yield and 18.5 million tonnes of sugar yield with a sugar recovery of 10.45 percent. Indian average productivity is little higher (69.6 t/ha) than the world average (65.69 t/ha) (Anon., 2001).

In Karnataka, sugarcane occupies an area of 42.1 lakh hectares with a production of 432 lakh tonnes of cane. The productivity of sugarcane in the state is high (102.7 t/ha) as compared to national average (69.6 t/ha) (Anon., 2001). Karnataka has tremendous potential for increasing the cane cultivation and achieving higher yields, as the soil and climatic conditions are most favourable for planting the cane in different seasons.

Sugarcane is raised as an irrigated crop in the state in ridges and furrow method, which leads to enormous wastage of irrigation water. About 20-30 cm of water is applied in each irrigation, which fails to bring additional yield but leads to a loss of water to the tune of 50 per cent when surface irrigation is adopted.

The use of conventional irrigation method not only results in considerable loss of water but it is also responsible for development of wide spread salinity/alkalinity, water logging and leaching of nutrients from the rhizosphere. Fertilizers applied under traditional methods of irrigation are not efficiently utilized by the crop and also threatens the ecological safety by polluting ground water.

Water and fertilizers are the two most important inputs in agricultural productivity, which are becoming scarce and costly day by day and hence use of these resources in most effective and efficient way is important. Under these circumstances, fertigation, a sophisticated and efficient method of applying fertilizers through drip irrigation system as a carrier and distributor of crop nutrients holds bright promise. This synergism of water and nutrients leads to efficient use of both by plants.

There are many advantages ascribed to fertigation system. Some of them as summarized by Papadopoulos (1992a) and Khan *et al.* (1996) are;

1. Improved fertilizer recovery leading to higher yield (typically 25 to 30 per cent increased yield)
2. Minimal losses due to leaching. Nitrogen efficiency recorded is at around 80-90 per cent with fertigation and perhaps only 50 per cent from the broadcast application
3. Control of nutrient concentration in the soil. Feasibility of timing of fertilizer application in relation to crop demand based on physiological stages of crop growth
4. Increased nutrient availability

5. Saving in quantity of fertilizers applied to an extent of 20 to 40 per cent
6. Saving in labour and energy in the application of fertilizers with no damage to root system

Keeping this in view, a field investigation was carried out on supplying of nitrogen and potassium through irrigation water i.e., fertigation and was compared with the soil application under surface system of irrigation with the following objectives:

1. Scheduling of rate and time of application of N and K_2O to sugarcane through fertigation
2. To study the effect of fertigation on yield and quality of sugarcane
3. To study the uptake of nutrients by the crop under fertigation and
4. To work out the economics of fertigation

Review of Literature

II. REVIEW OF LITERATURE

A field experiment entitled “Effect of fertigation on yield, quality and nutrient uptake of sugarcane” was conducted at Agricultural Research Station, Arabhavi, Gokak taluk, Belgaum district during the year 2001-2002. In this chapter a review of recent research work carried out on fertigation studies are presented.

2.1 STUDIES ON FERTIGATION

Application of fertilizers through the irrigation system (fertigation) has become a common practice in modern irrigated agriculture. Increased yields, improvement in quality of produce, irrigation and fertilizers expense efficiencies and protection of environment are some of the benefits of this method.

Use of fertigation in trickle irrigation system was reviewed by Haynes (1985). The advantages of the use of fertigation in trickle irrigation system included reduced labour, increased fertilizer efficiency and the increased flexibility of fertilizer application. Fujiyama and Naga (1987) opined that nutrient solution irrigation brought about a high nutrient recovery rate and appeared to be a suitable method for supplying nutrients and water. Fertigation allows nutrient placement directly into the plant root zone during critical periods of nutrient demand (Mikkelsen, 1989 and Kozhushk and Romanets, 1994).

Fertigation practices started in Mexico in the early 1960's, when NH_3 and 08N-24P-00K solutions were first injected into the open irrigation channels in northwest Mexico for wheat and cotton crops during the

middle 1970's Mexico was one of the leading countries in drip irrigation and fertigation. However, this practice was restricted during 1980's due to malfunctioning of some equipment as a result of improper maintenance. The most important fertigated crops are tomatoes, bell papers and other vegetable crops, grapes, oranges and other fruit crops. Highly soluble fertilizers suitable for fertigation are available in the market (Nunez-Escobar, 1995).

Neumann and Sneh (1995) reported that separate irrigation and soil fertilization practice decreases the nutrient status of the rhizosphere due to leaching by irrigation water. Fertigation avoids this problem and therefore it increases plant water expense efficiency i.e., biomass production per unit of water.

Bachchhav (1995) conducted a case study on fertigation in India by comparing fertigation with NPK over farmers' fertilizer practice with conventional fertilizers in terms of yield, quality and monitory returns. Weekly fertigation was found more convenient and economically profitable for the farmers.

Intensification of agriculture by irrigation and enhanced use of fertilizers may generate pollution by increasing levels of nutrients in underground and surface waters. Most of the irrigation by open system is having a relatively low efficiency of water application. A higher efficiency may be gained in pressurized irrigation system. Drip irrigation generates a restricted root system requiring frequent nutrient supply that can be satisfied by applying fertilizers in irrigation water i.e., by fertigation. Maximization of crop yield and quality and minimization of leaching losses below the rooting volume may be achieved by managing fertilizer

concentration in measured quantity of irrigation water according to the crop requirement (Hagin and Lowengart, 1994).

2.2 FERTILIZERS SUITABLE FOR FERTIGATION

Application of fertilizers through the irrigation system (fertigation) became a common practice in modern agriculture, because of the availability of completely water-soluble fertilizer materials of high grade. These fertilizers are made of same chemical compounds as those of normal fertilizers but they are devoid of neutral insoluble materials such as earth, gypsum, dolomite clay *etc.* Therefore, with pure nutrients in the manufactured products, they are 100 per cent soluble in water without leaving any sediment in fertigation or clog the sprayers when applied as foliar spray.

Urea is best suited for fertigation because it is highly soluble and does not react with water to form ions unless the enzyme urease is present. Possibility of such enzyme breakdown is less in fertigation. Calcium nitrate, ammonium nitrate urea, urea ammonium nitrate have all been successfully used as N-fertilizers for fertigation in Washington orchards. Careful evaluation of soil type, crops and irrigation management is necessary in selecting most appropriate type (Paryea, 1992).

Application of phosphorus through irrigation may cause precipitation problems. Phosphoric acid which is the concentrated form of phosphate containing 20-30 per cent P could be used as fertigation source of phosphorus. If irrigation water is low in calcium and magnesium, problems should be encountered in applying phosphoric acid through trickle system. In such situations, ammonium or potassium dihydrogen

orthophosphate could be used. Other soluble fertilizers available as P-sources are ammonium polyphosphates and nitro phosphates. A fertilizer compatibility test with the irrigation water should be conducted before injecting soluble P fertilizer in to trickle irrigation system (Mikkelsen, 1989 and Magen, 1995). The common sources of potassium (potassium chloride, sulphate and nitrate) are readily soluble in water and do not cause any precipitation problem in trickle line and emitters.

2.3 IMPACT OF FERTIGATION ON GROWTH AND YIELD

Keng *et al.* (1979) reported that yields of green pepper from broadcast fertilizer treatments were 15.8 per cent lower than from fertigation, and 12.3 per cent lower than from banded fertilizers and finally concluded that drip fertigation can be a promising alternative to currently used water-nutrient management methods for oxisols in the wet dry tropics.

Papadopoulos (1987) conducted two experiments with straw-berries to evaluate the effect of three N levels (3.6, 7.2 or 10.8 m mol N l⁻¹) and three N sources (urea, ammonium nitrate and phosphonitrate for supplying NH₄/NO₃ in m mol N l⁻¹ ratios of 7/0, 3.5/3.5 or 0/7) applied through drip system. The highest yield was obtained with 7.2 m mol N l⁻¹ owing to increase in both weight and number of fruits per plant. With this N concentration, soils EC_e and NO₃-N concentrations were kept at low levels. Among the N sources, the highest yield was obtained with urea owing to better fruit setting. The N-source had no effect on soil salinity and residual soil NO₃-N. Residual soil NO₃-N in soils receiving urea and ammonium nitrate was at low levels.

Crespo *et al.* (1988) applied N as urea to sweet pepper through drip system at 150, 300 or 500 kg ha⁻¹ in 11 applications. The commercial yield was markedly higher in mulched plots and it was highest (51.2 t/ha) on plots receiving nitrogen at 300 kg ha⁻¹ through drip irrigation. The zero N as control gave only 20.7 tonnes per hectare under mulch and 14.8 tonnes per hectare with no mulch.

Dasberg *et al.* (1988) carried out a long term trial in orange grove comparing broadcast versus continuous application of nitrogen through drip (80, 160, 280 kg ha⁻¹), 22 kg P ha⁻¹ and 126 kg K ha⁻¹ annually and concluded that fertigation of N at 160 kg ha⁻¹ resulted in higher yields than when the same amount was broadcasted. At high rates of application, no differences between modes of application were found.

Slangen *et al.* (1988) compared fertigation with broadcast application of N fertilizers at three localities in lettuce crop. The yields were comparable under both the systems but crop uniformity was better with fertigation owing to the absence of high nutrient concentration, frequently occurring with broadcast application. The crop NO₃ content could be kept within the levels found with the broadcasting provided fertigation ceased 10-14 days before the final harvest. Lower amounts of nutrients were needed and nutrient efficiency increased with fertigation as leaching was minimized. However, under wet soil conditions, fertigation was advantageous.

Bar-Yosef *et al.* (1989) applied phosphorus through surface and subsurface trickle system at 0.04, 0.16, 0.64 and 1.29 mol m⁻³ to sweet corn. Marketable ear yield increased with P concentration yielding 22.9, 24.3, 24.9 and 28.9 t ha⁻¹, respectively. Yield was higher for tricklers

placed 30 cm below the soil surface (25.2 t/ha) than the surface (23.5 t/ha). Elevated P concentration of irrigation water increased the soil solution P concentration, thereby increasing total P uptake and total dry matter production by the plants. Deep trickle placement significantly increased the fraction of total dry matter allocated to the ear, which resulted in higher marketable yield. Subsurface irrigation also reduced weed growth due to dry topsoil during the experiment.

Martinez *et al.* (1991) reported that surface fertigation increased the P and K content at the centre of root zone. The enhanced concentration apparently stimulated plant rooting, which together with the higher nutrient activity in the soil increased the P and K uptake rates which in turn resulted in the higher dry matter production and commercial yield (3.22 and 4.9 kg m⁻² of marketable and total ear yields of sweet corn, respectively) relative to subsurface fertigation (2.86 and 4.3 kg m⁻²).

Papadopoulos (1992b) reported that the highest yield of good quality tubers was obtained with P concentration applied through water at 40 mg l⁻¹ as compared to 0, 20 and 60 mg l⁻¹ in potato.

There was an increase in cane yield by 35.1 tonnes per hectare when nitrogen was applied through drip at 21 days interval as compared to the conventional method of fertilizer application with surface irrigation (Anon., 1993). Results of drip irrigation trials in Australia revealed that fertigation through the drip irrigation system gave similar result as conventional fertilizer application (Ridge and Hewson, 1995).

Nitrogen applied through drip irrigation increased the cane yield by 27 tonnes per hectare (Anon., 1996). Deshmukh *et al.* (1996) conducted a

study on fertigation for sugarcane to decide the nutrient level for arid and semi-arid sugar cane and reported that levels of nutrient equivalent to RDF, nutrient equivalent to 15 per cent lower than the RDF and nutrient equivalent to 30 per cent lower than recommended dose of fertilizers increased yield of cane by 27.32, 24.61 and 20.51 per cent, respectively, over conventional method of application of NPK at recommended dose. Geddawy and Dababy (1996) also reported that cane and sugar yields were higher under fertigation. Parikh *et al.* (1996) also reported that sugarcane yield was higher under fertigation.

Selvaraj *et al.* (1997) reported 32 per cent increase in yield of sugarcane with drip irrigation system along with application of 225 kg N ha⁻¹ compared to surface irrigation at same level of fertilizers. Fertigation of nitrogen significantly increased the cane yield over the conventional method of nitrogen application with surface irrigation. Highest cane yield was obtained when fertilizer was applied at 50 per cent of recommended dose through drip and was significantly superior over 100 per cent of fertilizers with surface irrigation (Anon., 1997b).

Shinde *et al.* (1998) obtained 25 per cent increase in cane yield with 20 splits of nitrogen application at weekly interval through drip, as compared with recommended fertilizer dose applied with surface irrigation. Fertigation of liquid fertilizers through drip resulted in 20.74 per cent yield increase over the conventional method of fertilizer application (Shinde *et al.*, 1999).

Ng Kee Kwong *et al.* (1999) obtained on par yields (162.3 t ha⁻¹) with application of 80 kg of nitrogen through drip as that of normal recommended dose of 120 kg N (170.1 t ha⁻¹) buried along the cane rows.

The cane yield was increased due to fertigation by 18.17 tonnes per hectare (straight fertilizers) and 32.3 tonnes per hectare (liquid fertilizers) as compared to conventional method of nitrogen application under surface method of irrigation (Bhoi *et al.*, 2000). The application of nitrogen through subsurface trickle irrigation significantly increased cane and sugar yield with the overall trend favouring the 90 (plant)/120 (ratoon) kg ha⁻¹ nitrogen treatment (Dart *et al.*, 2000). In the ratoon crop all the fertigated treatments produced higher cane and sugar yields in comparison with the non-fertigated treatments. Application of potassium in splits through drip tube had highest yield (Anon., 2000).

Shinde *et al.* (2000) reported that growth attributes of cane were significantly increased in fertigation treatments (with liquid fertilizers) compared to conventional method of soil application and also found that there was an increase in the yield of the cane by 20.74 per cent compared to conventional fertilizer application. Application of water-soluble N, P and K fertilizers significantly yielded more cane yield (153.35 t/ha) compared to straight fertilizers (141.76 t/ha) with drip irrigation and conventional fertilizers (115.74 t/ha) with surface irrigation (Bangar and Chaudhari, 2001).

2.4 IMPACT OF FERTIGATION ON QUALITY

Shinde *et al.* (1992) reported higher values of quality parameters for fertigation treatments than the conventional treatments. Juice analysis carried out at harvest showed that there was no significant differences in CCS per cent when nutridrip was supplied through either surface or subsurface drip irrigation (Deshmukh *et al.*, 1996).

Bhoi *et al.* (1999) reported that the quality parameters such as brix, pol and CCS per cent were improved slightly under drip irrigation and higher number of nitrogen splits. Increased fertilizer level through drip irrigation did not result in any significant improvement in quality parameters during both the seasons. However, in pooled analysis, significant improvement in juice quality was observed. Conventional treatment recorded lower values of all quality parameters as compared to rest of other treatments (Shinde *et al.*, 1999). The juice quality parameters such as brix, pol, purity and CCS were slightly improved when water soluble fertilizers were used in fertigation. These parameters were at maximum at the highest fertilizer level (Bhoi *et al.*, 2001). Application of either recommended dose of water soluble fertilizers or straight fertilizers at different grades i.e., 50, 75, 100 and 125 per cent of recommended dose did not vary brix, pol, purity and CCS per cent in sugarcane (Bangar and Chaudhari, 2001).

2.5 IMPACT OF FERTIGATION ON WATER USE EFFICIENCY

Higher water use efficiency of 0.539 MT/ha-cm, was observed when 125 per cent of nitrogen was supplied through drip system as compared to 0.27 MT/ha-cm in conventional method of fertilizer application (100% N) with furrow irrigation (Hapase *et al.*, 1993a).

Hapase *et al.* (1993a) reported highest water use efficiency (0.54 MT/ha-cm) when 75 per cent of N was applied through drip system compared to surface method with 100 per cent nitrogen (0.26 MT/ha-cm). The quantity of water applied through drip was 128.92 ha-cm as compared to 248.29 ha-cm in conventional surface irrigation method resulting in 48.07 per cent water saving. The water use efficiency was

maximum with 75 per cent of nitrogen (0.62 MT/ha-cm) through drip and was minimum in conventional method (0.28 MT/ha-cm) (Hapase *et al.* 1993b). The quantity of water used was 156.94 ha-cm and 144.89 ha-cm under surface and sub-surface drip irrigation, respectively as compared to 300 ha-cm under conventional method thereby saving 47.68 and 51.70 per cent water under surface and sub-surface drip irrigation, respectively. The highest water use efficiency (1.147 MT /ha-cm) was observed with 100 per cent nutridrip through drip (Deshmukh *et al.*, 1996).

Experiment conducted at Patna revealed that water use efficiency was improved by 1.9 to 2.0 times. Highest mean water and fertilizer use efficiencies were obtained under drip irrigation at 50 per cent of recommended dose of fertilizers (Anon., 1997b). Irrigation through drip at 40 per cent of surface method has produced 153 kg of sugarcane for one ha-mm of water, whereas it was only 69 kg under surface irrigation (Selvaraj *et al.*, 1997).

Shinde *et al.* (1998) reported that the quantity of water applied in drip irrigation was 132.81 ha-cm while in control it was 248.62 ha-cm. Thus, there was saving of 46.58 per cent water in drip irrigation compared to control. The water use efficiency in drip irrigation was in the range of 0.46 to 0.54 MT/ha-cm while in control it was 0.26 MT/ha-cm. Skip row planting with 20 splits of nitrogen at weekly interval resulted in 45 per cent water saving as compared to recommended fertilizer dose applied with surface irrigation. Maximum water use efficiency was observed with skipping one row after four rows (13.1 q/ha-cm) against conventional method (5.93 q/ha-cm).

Bhoi *et al.* (2000) reported that water applied through drip was 132.2 cm as compared to 277.10 cm in conventional surface irrigation method resulting in 42 per cent water saving. The water use efficiency ranged between 9.27 to 12.43 q/ha-cm in drip as compared to 5.33 q/ha-cm in surface method. Shinde *et al.* (2000) reported that in surface irrigation treatment, the irrigation water requirement was 175.28 cm of water, while it was hardly 86.66 cm in drip method. The water use efficiency was maximum with 125 per cent of recommended dose of liquid fertilizers (1567.4 kg/ha-cm) as compared to conventional method (583.8 kg/ha-cm).

2.6 IMPACT OF FERTIGATION ON FERTILIZER USE EFFICIENCY

Phene (1976) observed higher water and nitrogen use efficiency and lower leaching losses of nitrogen in sandy soils when nitrogen was applied with high efficiency trickle irrigation system. Haynes (1985) reported that injection of nutrients into irrigation water gives better crop response than either band or broadcast application.

Uptake of fertilizer N by sugarcane was indeed improved by supplying urea daily through the drip irrigation network system. Although N fertilizer use efficiency was nearly doubled by fertigating the sugarcane daily over 10 week period, the improvement in fertilizer use efficiency was however not accompanied by a correspondingly significant increase in cane or sugar yields (Ng Kee Kwong and Deville, 1994). Fertigation studies conducted by Flink *et al.* (1995) revealed that for wheat, when N was applied in accordance with crop demand the efficiency with which the applied fertilizer was utilized was increased and risk of N leaching decreased

Drip irrigation improved fertilizer use efficiency and resulted in 44 per cent yield increase in tomato. Using liquid fertilizer with drip could result in 25 per cent saving in fertilizer use over straight fertilizer (Vasane *et al.*, 1996). Fertilizer use efficiency in sugarcane was improved by 1.1 to 2.0 times by using fertilizers through drip. Highest mean fertilizer use efficiency was obtained under drip irrigation at 50 per cent of recommended dose of fertilizers (Anon., 1997a).

2.7 IMPACT OF FERTIGATION ON NUTRIENT UPTAKE

Stark *et al.* (1983) studied the uptake and partitioning of N by trickle irrigated tomatoes and the potential for distribution when N is continuously metered into the irrigation water. Solutions containing 1.8, 3.6 and 5.4 mol N m⁻³ were applied when the soil matrix potential at 25 mm depth reached either -10 or -30 kPa. The total N uptake which was nearly related to N application was lower than the amount applied at higher N rates. As the N application rate increased, an increasingly greater proportion of total plant N was portioned into vines. Denitrification N losses were lower in the two lowest N treatments due to competition between roots and denitrifiers.

Vasane *et al.* (1996) observed maximum uptake of nitrogen (211 kg/ha), phosphorus (45 kg P₂O₅/ha) and potassium (335 kg K₂O/ha) in the treatment with 100 per cent liquid fertilization with drip irrigation, which was on par with 75 per cent liquid fertilizer and 100 per cent straight fertilizer with drip irrigation. The N uptake increased with increase in N rates in drip irrigation system. Although, the N removed was more in 100 per cent liquid fertilizer treatment, but, the additional N assimilated showed little of 'Luxury-N' in vines.

Ng Kee Kwong *et al.* (1999) reported that the amount of total N and fertilizer N taken by sugarcane receiving 80 kg N/ha/annum by drip fertigation were comparable with those obtained with 120 kg N/ha/annum buried along the cane rows. Fertigation of nutrients through drip increased N, P and K content in the sugarcane plant by 9.86, 22.24 and 11.95 per cent over surface irrigation (Bangar and Chaudhari, 2001).

2.8 ECONOMIC VIABILITY OF FERTIGATION

Drip irrigation to sugarcane at 80 per cent of surface irrigation along with 225 kg N/ha recorded a total net income of Rs. 60,000/ha and at 40 per cent of surface irrigation with 175 kg/ha it was Rs. 53,000/ha. For every rupee investment there was a return of Rs. 2.22 to 2.37 under the drip system as compared to 2.03 under surface irrigation (Selvaraj *et al.*, 1997).

Berad *et al.* (1998) found that the application of only N (urea) through drip with normal planting performed well in respect of all yield attributes and registered 15 per cent higher yield (68.5 t/ha) and 7 per cent higher net returns (Rs. 1,09,130/ha) as compared to surface irrigation with same planting technique and fertilizer dose. But, high cost of liquid fertilizers (about 3.5 times) over solid fertilizers significantly reduced their economic viability substantially. Among the methods of water and fertilizer applications, fertigation method resulted in higher gross and net returns and hence maximum cost benefit ratio of 1:4.8, followed by drip method 1:3.81 and furrow method 1:3.47 in capsicum (Muralidhar, 1998).

Amarananjundeshwar *et al.* (1999) obtained higher profit when 100 per cent water soluble fertilizers were drip fertigated but, in terms of B:C ratio application of 100 per cent normal fertilizers under drip fertigation was found better with a ratio of 1:2.24 in potato crop. Venkateshmurthy *et al.* (1999) reported that application of 80 per cent normal fertilizers through drip irrigation was found to be most cost effective (1:2.93) in obtaining higher returns.

Fertigation of liquid fertilizers through drip resulted in 25 per cent saving in fertilizer and 20.74 per cent increase in yield. However, the high cost of liquid fertilizers significantly reduced the net profit and B:C ratio. From the economic point of view, skipped row planting (0:9 - 1.8 x 0.3 m) with application of recommended dose of fertilizers (250:125:125), but only N (urea) through drip in four splits was found better proposition with highest net returns (Rs. 55,103/ha) and B:C ratio (1.95) (Shinde *et al.*, 1999).

The average data of two years revealed that the drip system fertigated with water soluble fertilizers was marginally beneficial in terms of net seasonal returns (Rs. 62,407/ha) when compared with conventional fertilizers (Rs. 61,520/ha) in sugarcane and B:C ratio were 1.18 and 1.01 for conventional fertilizer and water soluble fertilizers, respectively (Bhoi *et al.*, 2000). Pawar *et al.* (2000) reported that the net seasonal income accrued was maximum under normal planting using straight fertilizers (Rs. 1,51,144/ha). Considering the additional area to be brought under irrigation due to water saving the total net income would be maximum under normal planting using straight fertilizers (Rs. 3,05,305/ha). The fruit yield of banana was increased by three to four tonnes per hectare

due to the application of water soluble fertilizers through drip when compared with conventional fertilizers. However, due to additional cost, water soluble fertilizers were not economical to use in fertigation as compared straight fertilizers.

Bangar and Chaudhari (2001) stated that the net seasonal income was found maximum with recommended dose of water soluble fertilizers (Rs. 64,347/ha) followed by straight fertilizers (Rs. 61,400/ha) in drip and surface (Rs. 50,200/ha) treatments. While B:C ratio was high in straight fertilizers (1.18) followed by surface irrigation (1.12) and recommended dose of water soluble fertilizers (1.04) .

Material and Methods

III. MATERIAL AND METHODS

The details of the materials employed and methods followed during the course of investigation on “Effect of fertigation on yield, quality and nutrient uptake of sugarcane” conducted during 2001-2002 at Agricultural research station, Arabhavi (Taluk: Gokak, District: Belgaum), are presented in this chapter.

3.1 LOCATION OF EXPERIMENTAL SITE

The experimental site is located at an altitude of 624.3 m from MSL and between latitude of $16^{\circ}00'$ and longitudes of $74^{\circ}05'$. The experiment was conducted on medium deep black soil having depth of 60 cm of ARS, Arabhavi (A block).

3.2 SOIL CHARACTERISTICS OF EXPERIMENTAL SITE

The soil of experimental site was medium black. The composite soil sample from 0 to 30 cm depth was collected from experimental area before planting of sugarcane and analysed for physical and chemical properties. The results of analysis along with methods employed are presented in Table 1.

3.3 METEOROLOGICAL PARAMETERS DURING THE CROPPING PERIOD

The data on climatic parameters such as rainfall, maximum and minimum temperatures and relative humidity of the ARS, Arabhavi, are presented in Table 2. During the period from April 2001 to January 2002, highest rainfall of 127.3 mm was received in the month of

Table 1. Physical and chemical properties of the soil in the experimental site

Sl. No.	Particulars	Values obtained	Method adopted
PHYSICAL PROPERTIES			
1.	Particle size analysis		
a.	Sand (%)	47.60	International pipette method (Piper, 1966)
b.	Silt (%)	18.70	
c.	Clay (%)	32.70	
CHEMICAL PROPERTIES			
1.	pH (soil water ratio 1:2.5)	8.23	pH meter (Jackson, 1967)
2.	EC (soil water extract) (dS m ⁻¹)	0.29	Electrical conductivity bridge (Jackson, 1967)
3.	Organic carbon (%)	0.51	Wet oxidation method (Jackson, 1967)
4.	Available N (kg ha ⁻¹)	224	Alkaline permanganate method (Subbaiah and Asija, 1956)
5.	Available P ₂ O ₅ (kg ha ⁻¹)	16.80	Olsen's method (Jackson, 1967)
6.	Available K ₂ O (kg ha ⁻¹)	340	Flame photometer (Jackson, 1967)

Table 2. Mean monthly meteorological data for the year 2001 and average of past 10 years (1990-2000) of Agricultural Research Station, Arabhavi

Months	Rainfall (mm)		Temperature (°C)					Mean Relative Humidity (%)	
			Max.		Min.				
			2001-02	Average of 10 years	2001-02	Average of 10 years	2001-02	Average of 10 years	2001-02
April	21.60	17.56	36.00	35.10	24.50	18.20	54.50	57.80	
May	6.10	65.96	35.45	34.40	25.52	19.90	54.28	63.30	
June	4.80	99.09	29.70	29.10	24.94	20.90	66.94	75.10	
July	45.00	74.31	25.45	28.30	23.11	19.90	70.02	79.10	
August	56.90	48.21	24.42	28.50	22.26	19.10	79.86	48.60	
September	127.30	91.49	24.77	29.20	22.30	18.30	78.08	74.80	
October	106.70	107.69	28.16	30.00	22.60	17.70	80.31	67.00	
November	0	14.13	28.57	28.70	21.22	14.10	77.20	65.70	
December	0	14.66	29.58	27.70	18.60	13.41	73.95	61.40	
January	0	0	29.69	29.40	13.50	12.40	68.21	62.00	
Total	368.40	533.10							

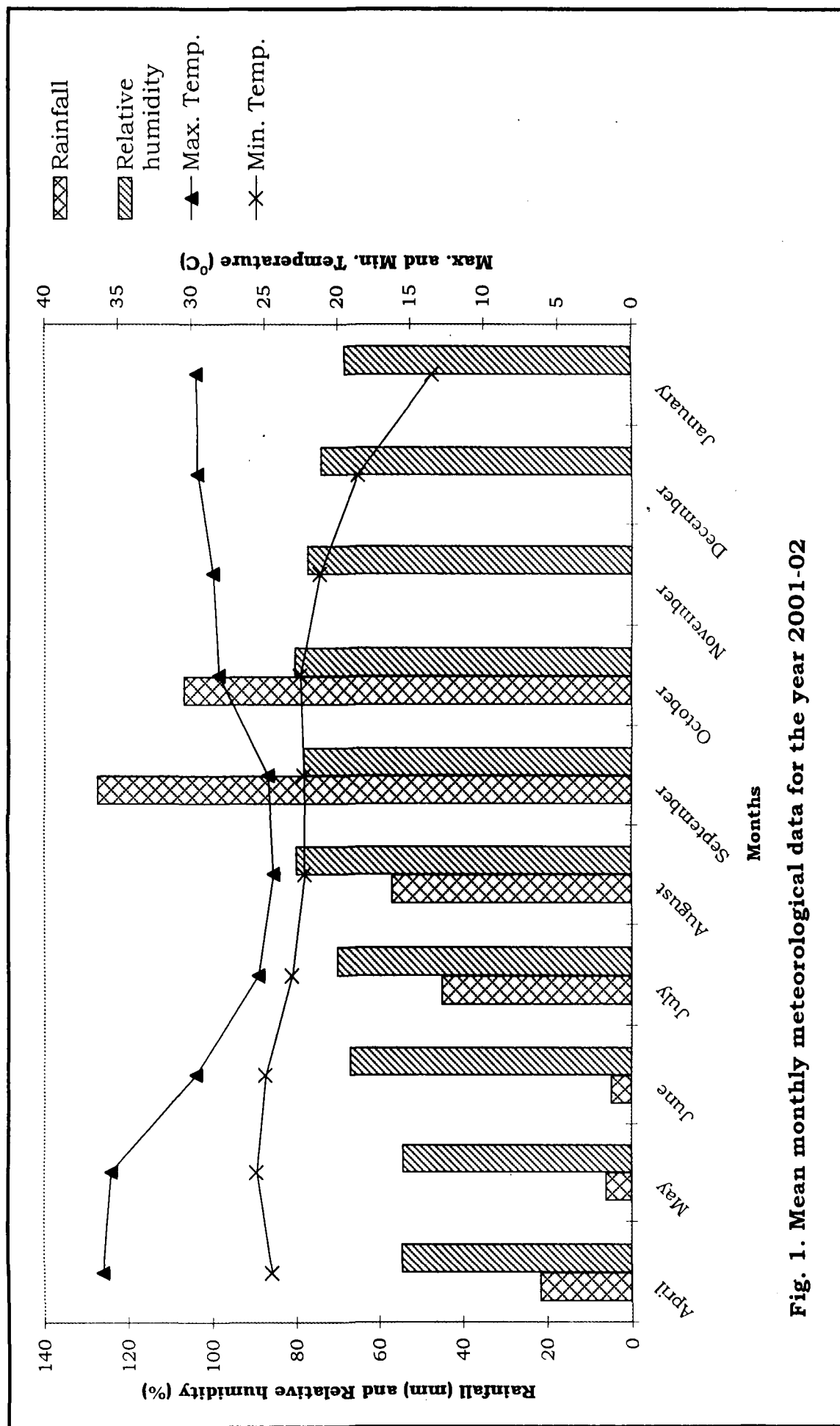


Fig. 1. Mean monthly meteorological data for the year 2001-02

September 2001. Lowest mean temperature was noticed in the month of January 2002 (12.40°C), while mean maximum temperature was recorded in the month of April 2001 (36.0°C). Relative humidity was maximum in October month (80.31%).

3.4 SEASON

Sugarcane was planted on 31st March, 2001 and harvested on 31st January, 2002.

3.5 CROP AND VARIETY

The cane variety CoC-671, was planted. It is a short duration variety that comes to maturity in 9-10 months with good sucrose content.

3.6 PREVIOUS CROP ON THE EXPERIMENTAL SITE

A crop of sunnhemp (*Crotalaria juncea*) was grown in the experimental site and was incorporated into the soil before planting of sugarcane.

3.7 EXPERIMENTAL DETAILS

The details of the experiment with regard to the treatments evaluated, the design adopted and plot size are given below.

3.7.1 Treatment details

1. Surface irrigation (SI) + soil application of recommended dose of N and K @ 250 and 185 kg/ha, respectively. Split application of only N @ 10, 20, 30 and 40 per cent of RDN at planting, 6, 10 and 14 WAP, respectively.

2. SI + soil application of recommended dose of N and K @ 250 and 185 kg/ha, respectively. Split application of both N and K @ 10, 20, 30 and 40 per cent at planting 6, 10 and 14 WAP, respectively.
3. Drip irrigation + soil application of recommended dose of N and K @ 250 and 185 kg/ha, respectively, split application of only N @ 10, 20, 30 and 40 per cent of RDN at planting, 6, 10 and 14 WAP, respectively.
4. Fertigation of 10 per cent N in equal splits during 30-60 DAP @ 5 kg/ha/time at 6 days interval + 20 per cent N in equal splits during 60-120 days @ 5 kg/ha/time at 6 days interval + 30 per cent N in equal splits during 120-180 days @ 7.5 kg/ha/time at 6 days interval + 40 per cent N in equal splits during 180-240 days @ 10 kg/ha/time at 6 days interval + soil application of K.
5. Fertigation of 250 kg N @ 7.14 kg/ha/time at 6 days interval in equal splits upto 240 DAP + soil application of K.
6. Fertigation of 250 kg N @ 7.14 kg/ha/time and 185 kg K @ 5.2 kg/ha/time at 6 days interval in equal splits up to 240 DAP.
7. Fertigation of 75 per cent of recommended dose of N @ 5.35 kg/ha/time and K @ 3.90 kg/ha/time at 6 days interval in equal splits up to 240 DAP.
8. Fertigation of 125 per cent of recommended dose of N @ 8.93 kg/ha/time and K @ 6.60 kg/ha/time at 6 days interval up to 240 DAP.

Note :

1. Soil application of recommended dose of P_2O_5 (75 kg/ha) at planting in all treatments.
2. Surface irrigation was scheduled at IW/CPE ratio of 1.0 throughout the crop growth period.
3. Irrigation interval under drip irrigation was 3 days.
4. Emitters were placed at a distance of 75 cm on the drip line.
5. Fertigation was scheduled at 6 days interval starting from one month after planting.
6. Method of planting was normal (0.9 m x 0.3 m).

3.7.2 Design and layout

The experiment was laid out in randomized block design with three replications. The layout plan adopted for the experiment is given in Figure 1.

3.7.3 Plot size

Gross plot size : 7.2 m x 6.0 m

Net plot size: 3.6 m x 3.0 m

3.8 CULTURAL PRACTICES**3.8.1 Land preparation**

Initially, the land was ploughed once with tractor drawn mould - board plough and later on worked twice with cultivator. The stubbles and weeds were picked from the experimental site. The land was then

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ – SI + N and K split

T₃ – DI + soil application of N and K

T₄ – Fertigation of 100% N in varied doses

T₅ – Fertigation of 100% N in equal doses

T₆ – Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

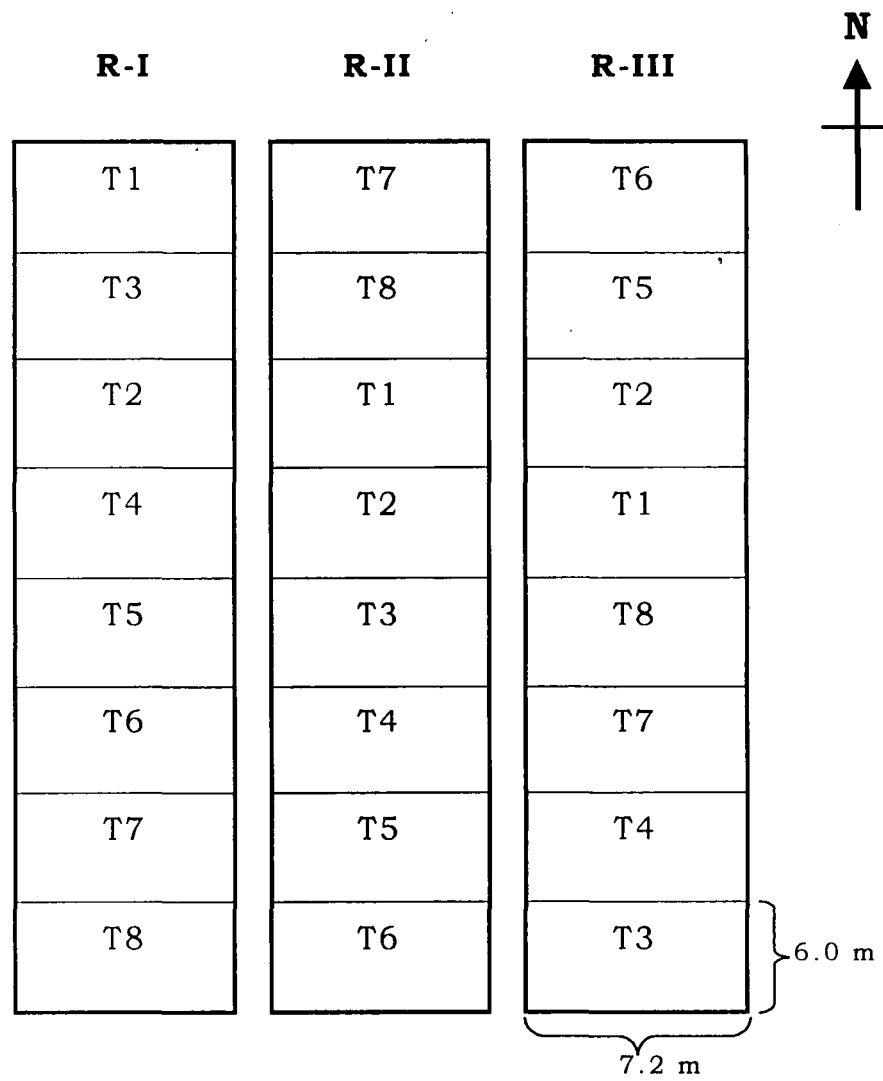


Figure 2. Plan of experimental layout

harrowed and smoothened to bring the soil to a fine tilth. Then ridges and furrows were formed at 90 cm distance.

3.8.2 Planting of cane setts

Healthy, pest and disease free setts were prepared from 9 months old sugarcane crop (Cv. CoC-671). A sett rate of 37,500 setts per ha were used for planting. The setts were treated with one per cent emisan (Bavistin) solution before planting. The setts were planted (31st March, 2001) in normal method. The setts were planted at a depth of 5 cm.

3.8.3 Fertilizer application

The recommended dose of fertilizer for sugarcane is 250:75:185 kg N, P₂O₅, and K₂O per ha. The entire P₂O₅ was applied as basal in the form of superphosphate. The recommended levels of N and K were applied through urea and muriate of potash in four splits in treatments T₁, T₂ and T₃. In fertigation treatments (T₄ and T₅) the recommended level of N was applied at 6 days interval starting from 30 DAP to 240 DAP in equal splits through drip and K was applied to soil. In treatments T₆, T₇ and T₈, entire quantity of N and K were applied through drip in equal splits starting from 30 DAP up to 240 DAP.

3.8.4 Irrigation

One common irrigation was given to all the treatments before planting.

For scheduling irrigation, data on daily pan evaporation rate recorded from USWB class 'A' open pan evaporimeter installed at ARS, Arabhavi meteorology observatory were utilized. Surface irrigation was

given at IW/CPE ratio of 1.0 i.e., whenever the cumulative pan evaporation reached 60 mm after the previous irrigation.

The quantity of water applied in drip irrigation is given in Appendix I. Drip irrigation was scheduled at an interval of three days.

3.8.5 Gap filling

Gap filling was done with the seedlings raised in the seed beds nearer to the main field after 40 DAP.

3.8.6 After care

Pre-emergence herbicide atrazine was applied at the rate of 1.0 kg a.i. ha⁻¹ on third day of planting followed by hand weeding at 40 and 65 days after planting. The earthing up was done 90 DAP.

3.8.7 Harvesting

The matured canes were cut at ground level individually in net plot area and were detopped, detrashed and weighed for final yield.

3.9 BIOMETRIC OBSERVATIONS

For recording biometric observations ten plants were selected at random from each net plot. The average values were used for analysis.

3.9.1 Sprouting percentage

The sprouting was recorded from the gross plot on 40th DAP and percentage was worked out by using the following formula.

$$\text{Sprouting percentage} = \frac{\text{No. of buds sprouted}}{\text{No. of buds planted}} \times 100$$

3.9.1 Number of tillers

The green tillers present in each treatment were counted and recorded as number of tillers per plant at 120 DAP and expressed in number of tillers per plant.

3.9.2 Plant height

The plant height was recorded from ground level to the base of the last fully opened leaf from randomly selected ten plants at 120, 180, 240 DAP and at harvest. The mean height of ten plants was recorded as plant height in centimeters.

3.9.3 Leaf area index (LAI)

The leaf area index (LAI) per plant was calculated by dividing the leaf area by the total land area provided to the plant, according to the formula given by Watson (1947), at 120, 180, 240 DAP and at harvest.

$$\text{Leaf area index (LAI)} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Land area occupied by the plant (cm}^2\text{)}}$$

3.9.4 Dry matter production

The plant samples were collected from each treatment and made into small pieces and kept for drying in sun. The semi dried material was kept into hot air oven at 80°C till the samples attained constant weight and the weight were recorded and was expressed in grams per plant. The mean dry matter of five selected plants from each plot was recorded at 120, 180, 240 DAP and at harvest.

3.9.5 Number of internodes per plant

The internodes present on the stalk up to the last fully opened leaf were recorded from ten plants in each net plot at 120, 180, 240 DAP and at harvest. The mean number of internodes per plant was worked out and depicted.

3.9.6 Girth of cane

The girth of millable canes was recorded at 120, 180, 240 DAP and at harvest exactly in the centre of sixth internode from the top using measuring tape and expressed in centimeters.

3.9.7 Length of internode

The length of the internodes present at top, middle and bottom portion of each cane was recorded at 120, 180, 240 DAP and at harvest and average of these recorded as mean internodal length and is expressed in centimeters.

3.10 YIELD COMPONENTS AND YIELD OF SUGARCANE

3.10.1 Number of millable canes

All the canes from each net plot were cut, detashed counted and recorded as number of millable canes per plot. These were expressed as millable canes per hectare.

3.10.2 Individual cane weight

The weight of ten millable canes was recorded at harvest and the average of those was worked out and expressed as weight of millable cane in kilogram.

3.10.3 Cane yield

All the canes in the net plot were cut close to the ground level. The tops and trash were removed and cane yield per plot was recorded. From this cane yield was expressed in tonnes per hectare.

3.10.4 Sugar yield or CCS yield

The sugar yield was calculated using the formula suggested by Sastry and Venkatachari.(1960).

$$\text{Sugar yield (t/ha)} = \frac{\text{CCS (\%)} \times \text{cane yield (t/ha)}}{100}$$

3.11 QUALITY PARAMETERS OF SUGARCANE

3.11.1 Juice extraction per cent

The juice extraction per cent was worked by using the following formula.

$$\text{Juice extraction per cent} = \frac{\text{Weight of juice (kg)}}{\text{Weight of millable cane (kg)}} \times 100$$

3.11.2 Brix reading

Brix reading was recorded by using the brix sacchrometer. Corrected brix reading was worked out by noting the room temperature at the time of observation with the help of bur standards.

3.11.3 Sucrose (Pol) percent

It was estimated by Horne's dry lead acetate clarification method using polariscope (Ishwaran, 1981). One hundred milliliter of the filtered

juice was transferred to the 250 ml conical flask to which one gram of basic lead acetate was added, stirred well and allowed to stand for about an hour until clear supernatant was obtained. This supernatant was filtered through Whatman No. 40 filter paper and the clarified juice was filled into a 20 mm polariscope tube and pol reading was recorded. The corrected pol readings were obtained by comparing the pol reading measured with the corresponding corrected brix reading referring to Schmitz table.

3.11.4 Purity of juice

It is the ratio between sucrose per cent and the corrected brix value expressed as per cent purity of juice.

$$\text{Purity percentage} = \frac{\text{Sucrose (\%)}}{\text{Corrected brix (\%)}} \times 100$$

3.11.5 Commercial cane sugar percentage

The commercial cane sugar percentage (CCS %) is the amount of white sugar commercially obtained from the juice after removing total soluble solids. It was calculated by using the formula.

$$\text{CCS \%} = [\text{Sucrose \%} - (\text{Brix \%} - \text{Sucrose \%}) \times 0.40 \times 0.73]$$

3.12 WATER USE STUDIES

3.12.1 Consumptive use

Consumptive use of water for the different treatments were computed as follows (Misra and Ahmed, 1982).

$$Cu = \sum_{i=1}^n (di + Re)$$

Where,

Cu = Consumptive use of crop

di = Applied water depth for each irrigation (mm)

Re = Effective rainfall (mm) for the cropping period

3.12.2 Water use efficiency (WUE)

The cane yield obtained for each treatment was divided by the quantity of water used consumptively for the respective treatments. By this method WUE was worked out and expressed in t/ha-cm of water used.

$$WUE \text{ (t/ha-cm)} = \frac{\text{Yield (t/ha)}}{\text{Total amount of water consumptively used (ha-cm)}}$$

3.13 SPAD readings (Chlorophyll meter)

SPAD readings were recorded by using SPAD or chlorophyll meter from the top three to six leaf from randomly selected ten plants at 120, 180 and 240 DAP and at harvest and these are averaged and presented.

3.14 NUTRIENT ANALYSIS

3.14.1 Plant analysis for NPK uptake

The samples of plant leaves collected from the fourth leaf counting downward from the first fully opened (3rd to 6th) leaf were used for the

analysis of plant nutrients. From the collected leaves, leaf blades (excluding midrib) were used for estimation of N and the leaf sheath were used for P and K estimation and contents were expressed in percentage. The chemical analysis were carried out by following methods.

The uptake was worked out by multiplying the total dry matter with per cent content of nutrient and expressed as kg/ha.

Nutrient	Method	Author
N	Microkjeldhal method	Jackson (1967)
P	Triacid extract digestion following Vanadomolybdate phosphoricacid yellow colour method	Jackson (1967)
K	Triacid extract – Flame photometer	Jackson (1967)

3.14.2 Soil analysis

After the harvest of the crop, soil samples were collected from each plot and are analysed as per the following procedure.

Nutrient	Method	Author
Available N (kg/ha)	Alkaline permanganate method	Subbaiah and Asija (1956)
Available P ₂ O ₅ (kg/ha)	Olsen's method	Jackson (1967)
Available K ₂ O (kg/ha)	Flame photometer method	Jackson (1967)

3.15 STATISTICAL ANALYSIS

Data recorded on various characters were subjected to Fisher's method of analysis of variance and interpreted as given in Gomez and Gomez (1984). The level of significance used in F test was $P=0.05$. Critical difference (CD) values were calculated at five per cent probability level, wherever, 'F' test was significant

3.16 ECONOMICS

Net monetary returns and benefit cost ratio were calculated based on prevailing market prices during the cropping period (Appendix III).

Experimental Results

IV. EXPERIMENTAL RESULTS

The results of the field experiment conducted at ARS, Arabhavi during the year 2001-2002, to investigate the “Effect of fertigation on yield, quality and nutrient uptake of sugarcane” are presented in this chapter.

4.1 INFLUENCE OF FERTIGATION ON GROWTH ATTRIBUTES

Cane growth and development were greatly influenced by the fertigation treatments except sprouting percentage. Other growth attributes like tiller production, dry matter production, cane length, internodal length, number of internodes and cane girth were recorded at different stages of crop growth and the data were subjected to statistical analysis and the results are presented hereunder.

4.1.1 Sprouting (%)

Sprouting is a critical process in the life of sugarcane plant. Good sprouting results in a good start, which provides healthy and strong basis for a better crop yield. Hence, the effect of fertigation practice on cane sprouting was recorded at 40 DAP and data are presented in Table 3.

The results clearly indicated that the sprouting percent was influenced by drip and fertigation treatments. The higher sprouting per cent of 78.67 was recorded with fertigation of 100 per cent N alone which was comparable with all other drip and fertigation treatments. The lower sprouting percentage of 72.00 at 40 DAP was recorded in surface method of irrigation with soil application of fertilizers.

Table 3. Sprouting percentage of sugarcane at 40 DAP as influenced by different fertigation treatments

Treatments	Sprouting (%)
T ₁ - SI + soil application of recommended N splits	72.00
T ₂ - SI + N and K split	72.33
T ₃ - DI + soil application of N and K	78.00
T ₄ - Fertigation of 100% N in varied doses	78.00
T ₅ - Fertigation of 100% N in equal doses	78.67
T ₆ - Fertigation of 100% N and K	78.33
T ₇ - Fertigation of 75% N and K	77.00
T ₈ - Fertigation of 125% N and K	76.67
S.Em±	0.71
CD (0.05)	2.17

SI = Surface irrigation

DI = Drip irrigation

DAP = Days after planting

4.1.2 Number of tillers

The data on the number of tillers in sugarcane at 120 DAP as influenced by fertigation are presented in Table 4.

The tiller count recorded at 120 DAP indicated a positive response to fertigation. The results clearly indicated that increased level of fertilizer application tended to increase tiller production. Fertigation of 125 per cent N and K (T₈) recorded higher number of tillers of 15.03 per plant than 9.81 per plant, recorded in soil application of fertilizers with surface irrigation (T₁). Fertigation of 125 per cent N and K (T₈) was comparable with all other fertigation treatments (T₄, T₅, T₆ and T₇).

4.1.3 Cane length (cm)

The growth of the crop was measured in terms of plant height. Hence, this character was studied from 120 DAP to harvest at 60 days interval. The data on cane length of sugarcane at various growth stages as influenced by fertigation treatments are presented in the Table 5.

Fertigation treatments significantly influenced the cane length at all the stages. Among the fertigation treatments, fertigation of 125 per cent of N and K (T₈) recorded higher cane length at 120 DAP (120.67), 180 (225.00), 240 (244.00) and at harvest (288.00) compared to soil application of fertilizers with surface irrigation (T₁), which recorded lower cane length at 120 DAP (93 cm), 180 DAP (176 cm), 240 DAP (178.67 cm) and at harvest (234.33 cm). Plant height at fertigation of 125 per cent of N and K (T₈) was on par with all other fertigation treatments (T₄, T₅, T₆ and T₇).

Table 4. Number of tillers per plant of sugarcane at 120 DAP as influenced by different fertigation treatments

Treatments	Number of tillers per plant
T ₁ - SI + soil application of recommended N splits	9.81
T ₂ - SI + N and K split	10.32
T ₃ - DI + soil application of N and K	11.34
T ₄ - Fertigation of 100% N in varied doses	14.04
T ₅ - Fertigation of 100% N in equal doses	14.28
T ₆ - Fertigation of 100% N and K	14.85
T ₇ - Fertigation of 75% N and K	14.18
T ₈ - Fertigation of 125% N and K	15.03
S.Em _±	0.03
CD (0.05)	0.08

SI = Surface irrigation
 DI = Drip irrigation
 DAP = Days after planting

Table 5. Cane length (cm) of sugarcane at different stages as influenced by different fertigation treatments

Treatments	120 DAP	180 DAP	240 DAP	At harvest
T ₁ - SI + soil application of recommended N splits	93.00	176.00	178.67	234.33
T ₂ - SI + N and K split	94.67	176.00	183.33	234.67
T ₃ - DI + soil application of N and K	105.00	197.67	207.00	260.00
T ₄ - Fertigation of 100% N in varied doses	116.00	219.68	230.33	284.67
T ₅ - Fertigation of 100% N in equal doses	118.33	220.33	233.33	248.67
T ₆ - Fertigation of 100% N and K	119.67	224.67	241.00	287.67
T ₇ - Fertigation of 75% N and K	115.33	214.33	218.67	264.00
T ₈ - Fertigation of 125% N and K	120.67	225.00	244.00	288.00
S.E.m _±	3.34	7.02	7.67	7.90
CD (0.05)	10.14	21.30	23.25	23.97

SI = Surface irrigation
DI = Drip irrigation
DAP = Days after planting

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ - SI + N and K split

T₃ - DI + soil application of N and K

T₄ - Fertigation of 100% N in varied doses

T₅ - Fertigation of 100% N in equal doses

T₆ - Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

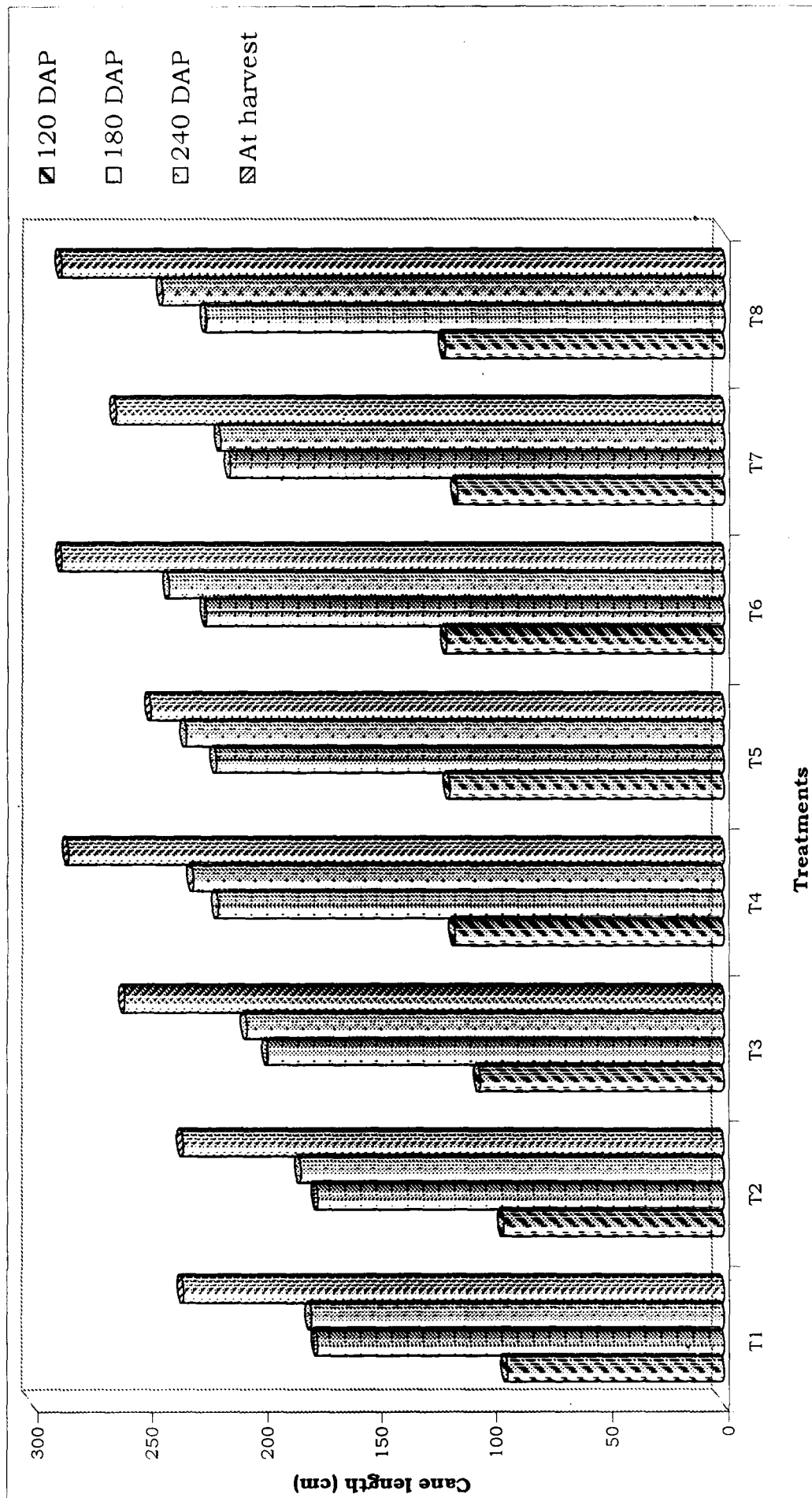


Fig. 3. Cane length of sugarcane at different stages as influenced by fertilization treatments

4.1.4 Number of internodes

The data on number of internodes as influenced by fertigation treatments at 120, 180, 240 DAP and at harvest are presented in Table 6.

The number of internodes in sugarcane differed significantly at various growth stages. The numbers of internodes increased progressively from 120 DAP till harvest. The fertigation treatments recorded significantly higher number of internodes at all the stages compared to soil application of fertilizers with surface and drip irrigation. The higher number of internodes (24.23) was recorded in fertigation of 125 per cent N and K (T_8) at harvest than soil application of fertilizers (T_1) with surface irrigation (16.33). The same trend was followed at all the growth stages. Fertigation of 125 per cent N and K (T_8) was on par with all other fertigation treatments (T_4 , T_5 and T_6). Fertigation of 75 per cent of N and K was not on par with 125 per cent N and K at 180 DAP.

4.1.5 Length of internodes (cm)

The data on internodal length at 120, 180 and 240 DAP and at harvest as influenced by different fertigation treatments are presented in Table 7.

Fertigation treatments significantly influenced the internodal length at all the stages. Fertigation of 125 per cent of N and K (T_8) at 120 (10.95 cm), 180 (12.45 cm), 240 (16.41 cm) DAP and at harvest (16.53 cm) recorded significantly higher internodal length compared to soil application of fertilizer with surface irrigation (T_1). Internodal length at fertigation of 125 per cent N and K (T_8) was on par with other fertigation

Table 6. Number of internodes of sugarcane at different stages as influenced by different fertigation treatments

Treatments	120 DAP	180 DAP	240 DAP	At harvest
T ₁ - SI + soil application of recommended N splits	3.37	9.00	14.60	16.33
T ₂ - SI + N and K split	3.53	9.10	15.33	16.50
T ₃ - DI + soil application of N and K	4.13	10.42	17.67	18.50
T ₄ - Fertigation of 100% N in varied doses	4.77	11.67	20.20	21.67
T ₅ - Fertigation of 100% N in equal doses	4.87	11.83	20.47	21.87
T ₆ - Fertigation of 100% N and K	5.13	12.37	21.07	23.03
T ₇ - Fertigation of 75% N and K	4.77	11.03	19.20	21.47
T ₈ - Fertigation of 125% N and K	5.37	12.77	22.13	24.23
S.Em±	0.16	0.41	0.53	0.59
CD (0.05)	0.49	1.24	1.61	1.79

SI = Surface irrigation
 DI = Drip irrigation
 DAP = Days after planting

Table 7. Internodal length (cm) of sugarcane at different stages as influenced by different fertigation treatments

Treatments	120 DAP	180 DAP	240 DAP	At harvest
T ₁ - SI + soil application of recommended N splits	7.60	8.37	11.93	12.00
T ₂ - SI + N and K split	7.68	8.83	11.97	12.07
T ₃ - DI + soil application of N and K	8.90	10.38	13.95	14.07
T ₄ - Fertigation of 100% N in varied doses	10.08	11.83	15.92	16.03
T ₅ - Fertigation of 100% N in equal doses	10.13	11.93	16.00	16.13
T ₆ - Fertigation of 100% N and K	10.27	12.05	16.02	16.33
T ₇ - Fertigation of 75% N and K	9.88	10.72	14.97	15.57
T ₈ - Fertigation of 125% N and K	10.95	12.45	16.41	16.53
S.Em _±	0.37	0.46	0.63	0.62
CD (0.05)	1.14	1.41	1.92	1.88

SI = Surface irrigation
 DI = Drip irrigation
 DAP = Days after planting

treatments (T₄, T₅ and T₆), except fertigation of 75 per cent of N and K, which was not on par at 180 DAP.

4.1.6 Girth of internode (Table 8)

Distinct variation in girth of cane at different growth stages existed due to fertigation treatments. Fertigation favourably influenced the cane girth compared to soil application of fertilizers. Fertigation of 125% N and K (T₈) recorded higher cane girth of 12.63 cm at harvest as compared to 9.77 cm in soil application of fertilizers with surface irrigation (T₁). The same trend was followed at all the stages of crop growth. Fertigation of 125 per cent of N and K (T₈) was on par with other fertigation treatments (T₄, T₅ and T₆) except fertigation of 75 per cent N and K, which was not on par at 120 and 180 DAP.

4.1.7 Leaf area index (LAI)

Crop growth rate is generally influenced by LAI and related to both biological and economical yield. Hence, LAI was assessed at different growth stages up to harvest. In general, LAI increased linearly and attained a maximum at 240 DAP and thereafter declined. The data on LAI at various growth stages as influenced by fertigation treatments are presented in Table 9.

All the fertigation treatments significantly recorded higher LAI at all the stages of crop growth, at 120, 180 and 240 DAP and at harvest. Fertigation of 125 per cent N and K (T₈) recorded significantly higher LAI of 6.34 at harvest than soil application (T₁) of fertilizers with surface irrigation (4.49). Similar trend was followed at all the stages of crop growth. LAI at fertigation of 125 per cent N and K (T₈) was on par with

Table 8. Cane girth (cm) of sugarcane at different stages as influenced by different fertigation treatments

Treatments	120 DAP	180 DAP	240 DAP	At harvest
T ₁ - SI + soil application of recommended N splits	8.95	9.30	9.62	9.77
T ₂ - SI + N and K split	9.15	9.33	9.75	9.85
T ₃ - DI + soil application of N and K	10.13	10.30	10.73	10.90
T ₄ - Fertigation of 100% N in varied doses	11.03	11.20	11.73	11.99
T ₅ - Fertigation of 100% N in equal doses	11.02	11.27	11.73	11.99
T ₆ - Fertigation of 100% N and K	11.10	11.40	11.83	12.53
T ₇ - Fertigation of 75% N and K	10.30	10.47	11.11	11.78
T ₈ - Fertigation of 125% N and K	11.30	11.77	11.92	12.63
S.Em _±	0.27	0.28	0.29	0.30
CD (0.05)	0.83	0.86	0.87	0.92

SI = Surface irrigation
 DI = Drip irrigation
 DAP = Days after planting

Table 9. Leaf area index (LAI) of sugarcane at different stages as influenced by different fertigation treatments

Treatments	120 DAP	180 DAP	240 DAP	At harvest
T ₁ - SI + soil application of recommended N splits	1.74	2.25	5.05	4.49
T ₂ - SI + N and K split	1.75	2.25	5.09	4.82
T ₃ - DI + soil application of N and K	1.80	2.92	5.75	5.45
T ₄ - Fertigation of 100% N in varied doses	1.94	3.32	6.44	6.12
T ₅ - Fertigation of 100% N in equal doses	1.95	3.27	6.67	6.20
T ₆ - Fertigation of 100% N and K	2.02	3.46	6.89	6.28
T ₇ - Fertigation of 75% N and K	1.93	3.26	6.32	5.94
T ₈ - Fertigation of 125% N and K	2.18	3.52	7.06	6.34
S.E.m _±	0.09	0.09	0.21	0.21
CD (0.05)	0.27	0.29	0.64	0.64

SI = Surface irrigation
 DI = Drip irrigation
 DAP = Days after planting

other fertigation treatments (T₄, T₅ and T₆) except fertigation of 75 per cent N and K, which was not on par at 240 DAP.

4.1.8 Dry matter production (g/plant)

The data on dry matter production at various growth stages as influenced by fertigation treatments are presented in Table 10.

There was significant differences in dry matter production due to fertigation treatments. Fertigation treatments favourably influenced the dry matter production at all the stages. The results clearly indicated that irrespective of the stage of the crop, fertigation treatments recorded significantly higher dry matter production compared to soil application of fertilizers with surface and drip irrigation. The higher dry matter production of 403.61 g per plant was recorded at harvest in fertigation of 125 per cent N and K (T₈) than 368.24 g per plant in soil application of fertilizers with surface irrigation (T₁). Similar trend was observed at all the stages of crop growth. Dry matter production at fertigation of 125 per cent N and K (T₈) was on par with other fertigation treatments (T₄, T₅ and T₆) except fertigation of 75 per cent N and K, which was not on par at harvest.

4.2 YIELD ATTRIBUTES

The yield attributes *viz.*, single cane weight and number millable canes were favorably influenced by fertigation treatments.

4.2.1 Number of millable canes

The data on number of millable canes per ha as influenced by different fertigation treatments are presented in Table 11.

Table 10. Dry matter production (g/plant) of sugarcane at different stages as influenced by different fertigation treatments

Treatments	120 DAP	180 DAP	240 DAP	At harvest
T ₁ - SI + soil application of recommended N splits	132.46	240.56	314.97	368.24
T ₂ - SI + N and K split	134.32	242.56	344.78	370.18
T ₃ - DI + soil application of N and K	142.83	253.14	354.94	382.21
T ₄ - Fertigation of 100% N in varied doses	151.19	262.60	365.68	393.17
T ₅ - Fertigation of 100% N in equal doses	151.29	263.44	365.68	393.80
T ₆ - Fertigation of 100% N and K	151.36	266.65	368.51	396.74
T ₇ - Fertigation of 75% N and K	147.50	261.81	364.78	390.89
T ₈ - Fertigation of 125% N and K	153.65	269.95	371.10	403.61
S.Em _±	2.64	2.93	3.04	3.47
CD (0.05)	8.00	8.89	9.24	10.52

SI = Surface irrigation
 DI = Drip irrigation
 DAP = Days after planting

Table 11. Number of millable canes of sugarcane as influenced by different fertigation treatments

Treatments	Millable canes/ha
T ₁ - SI + soil application of recommended N splits	71368
T ₂ - SI + N and K split	71526
T ₃ - DI + soil application of N and K	77957
T ₄ - Fertigation of 100% N in varied doses	84538
T ₅ - Fertigation of 100% N in equal doses	84686
T ₆ - Fertigation of 100% N and K	85994
T ₇ - Fertigation of 75% N and K	80541
T ₈ - Fertigation of 125% N and K	86918
S.E.m _±	2087
CD (0.05)	6330

SI = Surface irrigation
DI = Drip irrigation

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ - SI + N and K split

T₃ - DI + soil application of N and K

T₄ - Fertigation of 100% N in varied doses

T₅ - Fertigation of 100% N in equal doses

T₆ - Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

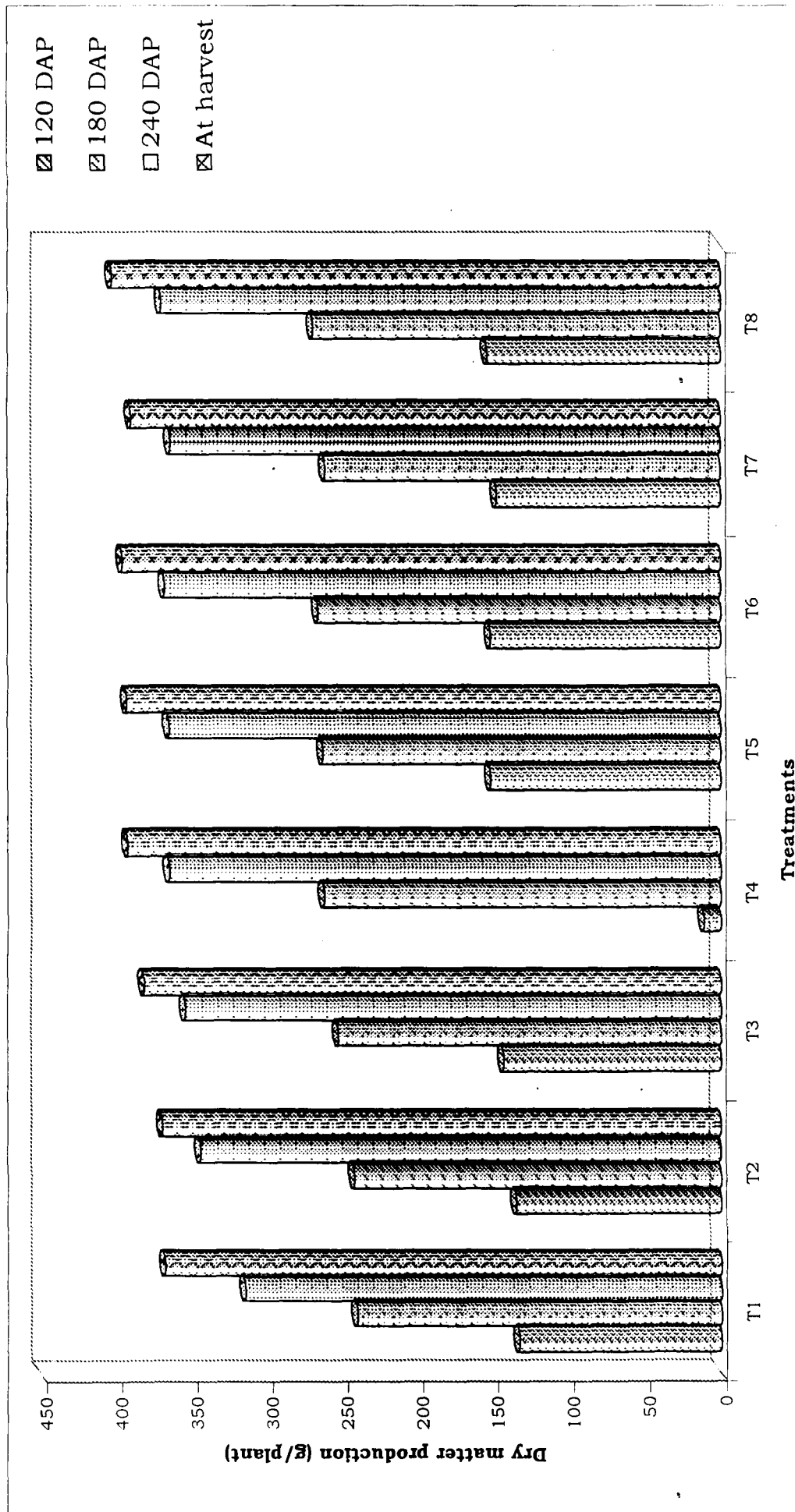


Fig. 4. Dry matter production of sugarcane at different stages as influenced by fertilization treatments

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ - SI + N and K split

T₃ - DI + soil application of N and K

T₄ - Fertigation of 100% N in varied doses

T₅ - Fertigation of 100% N in equal doses

T₆ - Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

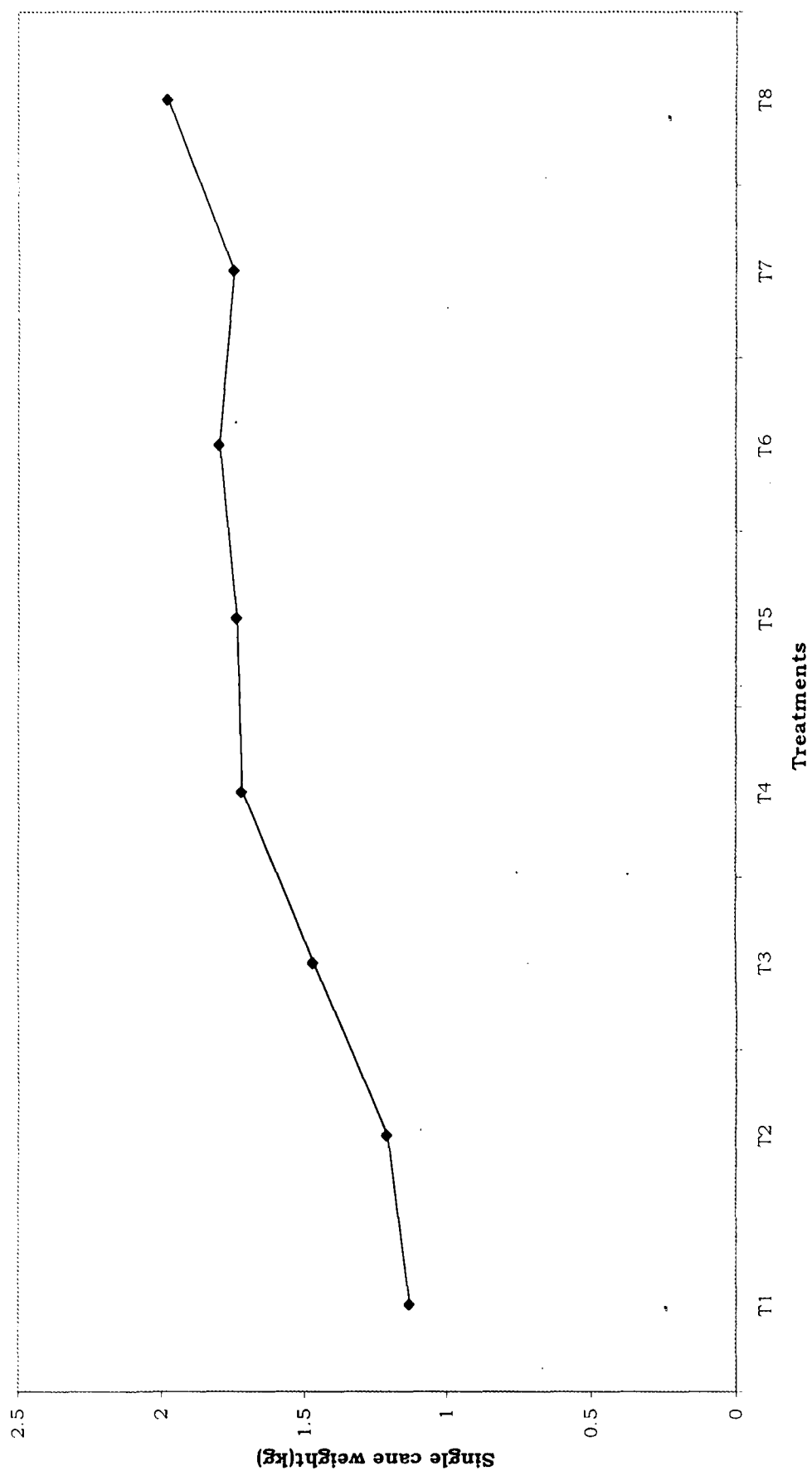


Fig. 5. Single cane weight of sugarcane as influenced by fertigation treatments

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ - SI + N and K split

T₃ - DI + soil application of N and K

T₄ - Fertigation of 100% N in varied doses

T₅ - Fertigation of 100% N in equal doses

T₆ - Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

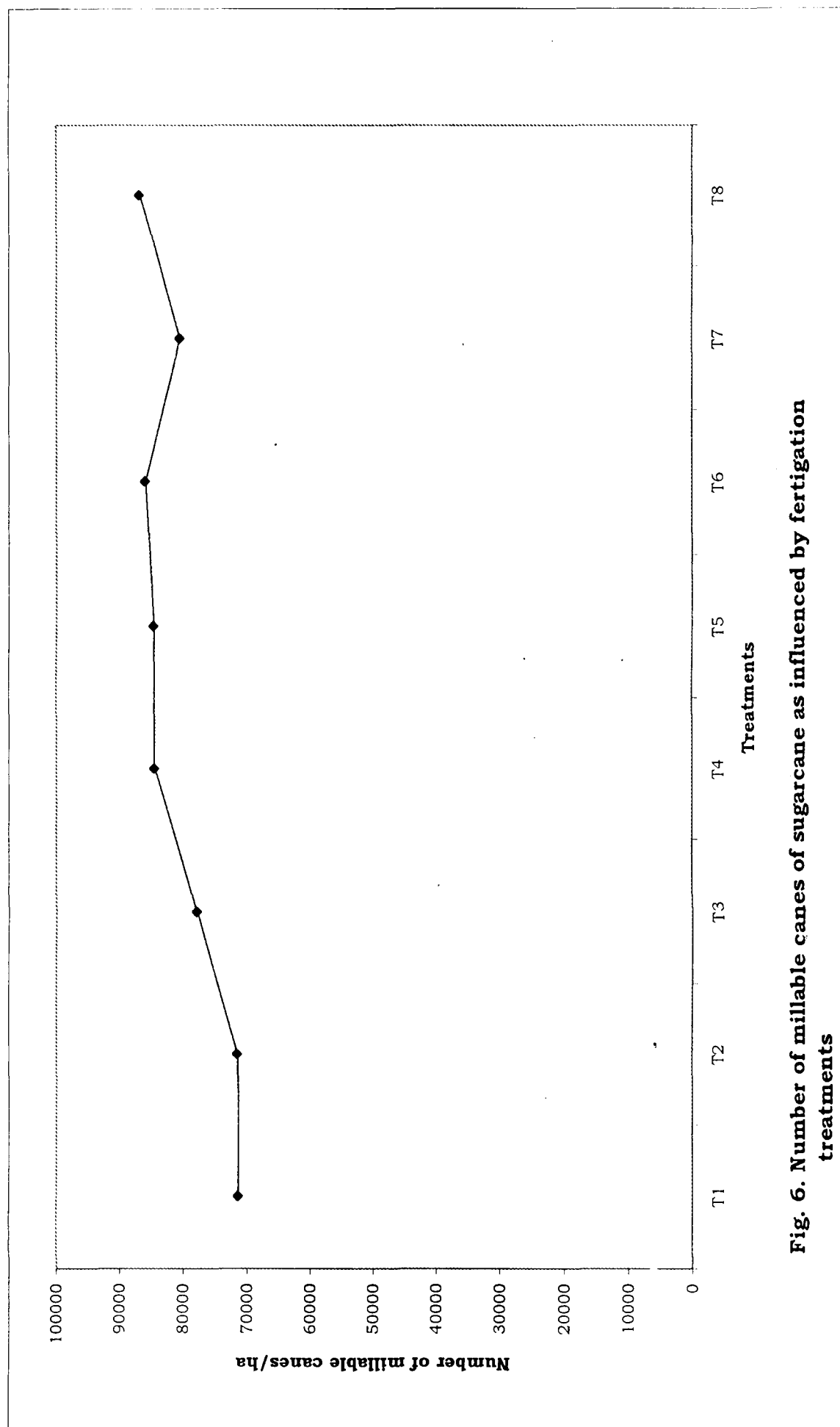


Fig. 6. Number of millable canes of sugarcane as influenced by fertigation treatments

The results clearly indicated that the number of millable canes was greatly influenced by fertigation treatments. Among fertigation treatments fertigation of 125 per cent N and K (T₈) recorded significantly higher number of millable canes (86,918/ha) than soil application of fertilizers (T₁, T₂ and T₃) but was on par with other fertigation treatments (T₄, T₅, T₆ and T₇).

4.2.2 Single cane weight (kg)

Single cane weight is one of the important yield parameters that greatly influenced the cane yield, indicated a positive influence by fertigation treatments. Table 12 shows the data on single cane weight (kg) as influenced by different fertigation treatments.

The results on single cane weight indicated that fertigation treatments significantly influenced the single cane weight. Among fertigation treatments, fertigation of 125 per cent N and K (T₈) recorded significantly higher single cane weight (1.98 kg) compared to soil application of fertilizers either through surface or drip irrigation (T₁, T₂ and T₃) but, it was on par with other fertigation treatments (T₄, T₅, T₆ and T₇). Soil application of fertilizers through surface irrigation (T₁) recorded lower single cane weight (1.13 kg).

4.2.3 Cane yield (t/ha)

The data on cane yield of sugarcane as influenced by different fertigation treatment are presented in Table 13.

Fertigation treatments extended a positive influence on cane yield. Fertigation increased the cane yield compared to soil application of

Table 12. Single cane weight (kg) of sugarcane as influenced by different fertigation treatments

Treatments	Single cane weight(kg)
T ₁ - SI + soil application of recommended N splits	1.13
T ₂ - SI + N and K split	1.21
T ₃ - DI + soil application of N and K	1.47
T ₄ - Fertigation of 100% N in varied doses	1.72
T ₅ - Fertigation of 100% N in equal doses	1.74
T ₆ - Fertigation of 100% N and K	1.80
T ₇ - Fertigation of 75% N and K	1.75
T ₈ - Fertigation of 125% N and K	1.98
S.E.m _±	0.10
CD (0.05)	0.30

SI = Surface irrigation
DI = Drip irrigation

fertilizers. The cane yield increased marginally due to split application potassium through drip.

Fertigation of 125 per cent N and K (T₈) recorded significantly higher cane yield of 143.74 t per ha than 106.48 t per ha recorded in soil application of fertilizers with surface irrigation (T₁). The yield at fertigation of 125 per cent N and K (T₈) was on par with all other fertigation treatments (T₄, T₅, T₆ and T₇).

4.2.4 Sugar yield (t/ha)

The data on sugar yield (t/ha) as influenced by different fertigation treatments are presented in Table 13.

Drip and fertigation treatments resulted in significantly higher sugar yield than that of surface irrigation and soil application of fertilizers.

Fertigation of 125 per cent N and K (T₈) recorded higher sugar yield of 21.88 t per ha than 13.52 t per ha recorded at soil application of fertilizers with surface irrigation (T₁).

Drip irrigation and soil application of fertilizer (T₃) produced higher sugar yield than surface irrigation treatments (T₁ and T₂) but significantly lower yield than fertigation treatments. Sugar yield at fertigation of 125 per cent N and K was on par with fertigation of 100 per cent N and K (T₅ and T₆, respectively). But, fertigation of 100 per cent N (T₄) and 75 per cent N and K (T₇) was not on par with fertigation of 125 per cent N and K.

Table 13. Cane yield and sugar yield as influenced by different fertigation treatments

Treatments	Cane yield (t/ha)	Sugar yield (t/ha)
T ₁ - SI + soil application of recommended N splits	106.48	13.52
T ₂ - SI + N and K split	109.32	14.16
T ₃ - DI + soil application of N and K	121.18	16.64
T ₄ - Fertigation of 100% N in varied doses	132.98	19.43
T ₅ - Fertigation of 100% N in equal doses	134.10	19.72
T ₆ - Fertigation of 100% N and K	141.43	20.65
T ₇ - Fertigation of 75% N and K	135.71	18.46
T ₈ - Fertigation of 125% N and K	143.74	21.88
S.Em±	3.87	0.80
CD (0.05)	11.74	2.43

SI = Surface irrigation
DI = Drip irrigation

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ - SI + N and K split

T₃ - DI + soil application of N and K

T₄ - Fertigation of 100% N in varied doses

T₅ - Fertigation of 100% N in equal doses

T₆ - Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

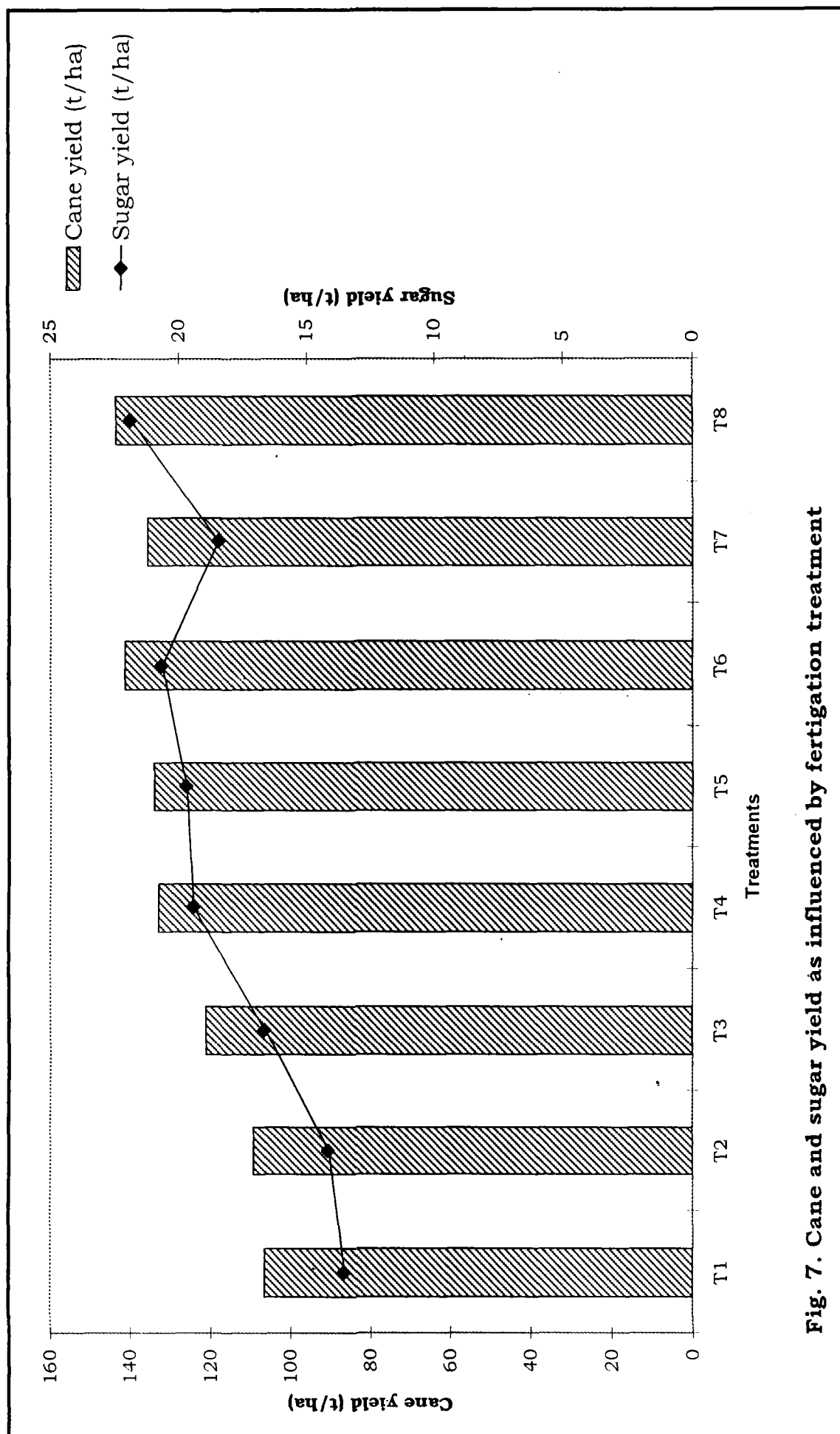


Fig. 7. Cane and sugar yield as influenced by fertigation treatment

4.3 JUICE QUALITY ATTRIBUTES

The data on important juice quality components such as juice brix, pol per cent, CCS per cent, purity per cent and juice extraction per cent determined at the time of harvest are presented in Table 14 and 15.

4.3.1 Juice brix

The value of brix did not differ significantly due to fertigation treatments. However, brix value of 23.08 was obtained with fertigation of 125 per cent N and K (T₈) as compared to 21.31 in soil application of fertilizers with surface irrigation (T₁). Brix value at fertigation of 125 per cent N and K (T₈) was on par with brix value at fertigation of 100 and 75 per cent N and K (T₆ and T₇).

4.3.2 Juice sucrose (pol) per cent

The data on pol per cent in juice (Table 14) clearly indicate that fertigation treatments did not influence the pol per cent significantly. However, higher values were observed with the fertigation treatments. Fertigation of 125 per cent N and K (T₈) recorded higher pol per cent of 21.45 than 18.52 per cent recorded in soil application of fertilizers with surface irrigation (T₁). Pol per cent at fertigation of 125 per cent N and K (T₈) was on par with pol per cent at fertigation 100 per cent N and K (T₆ and T₇).

4.3.3 Commercial cane sugar percentage (CCS per cent)

The data on CCS per cent as influenced by fertigation treatments are given in Table 14.

Table 14. Brix, Pol (%) and CCS (%) of cane juice as influenced by different fertigation treatments

Treatments	Brix	Pol (%)	CCS (%)
T ₁ - SI + soil application of recommended N splits	21.31	18.58	12.76
T ₂ - SI + N and K split	21.53	18.82	12.95
T ₃ - DI + soil application of N and K	21.56	19.09	13.21
T ₄ - Fertigation of 100% N in varied doses	21.59	19.37	13.49
T ₅ - Fertigation of 100% N in equal doses	21.84	19.90	14.05
T ₆ - Fertigation of 100% N and K	22.86	20.81	14.60
T ₇ - Fertigation of 75% N and K	22.75	19.79	13.60
T ₈ - Fertigation of 125% N and K	23.08	21.15	14.88
S.Em _±	0.96	0.72	0.52
CD (0.05)	NS	NS	NS

SI = Surface irrigation

DI = Drip irrigation

CCS = Commercial cane sugar

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ - SI + N and K split

T₃ - DI + soil application of N and K

T₄ - Fertigation of 100% N in varied doses

T₅ - Fertigation of 100% N in equal doses

T₆ - Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

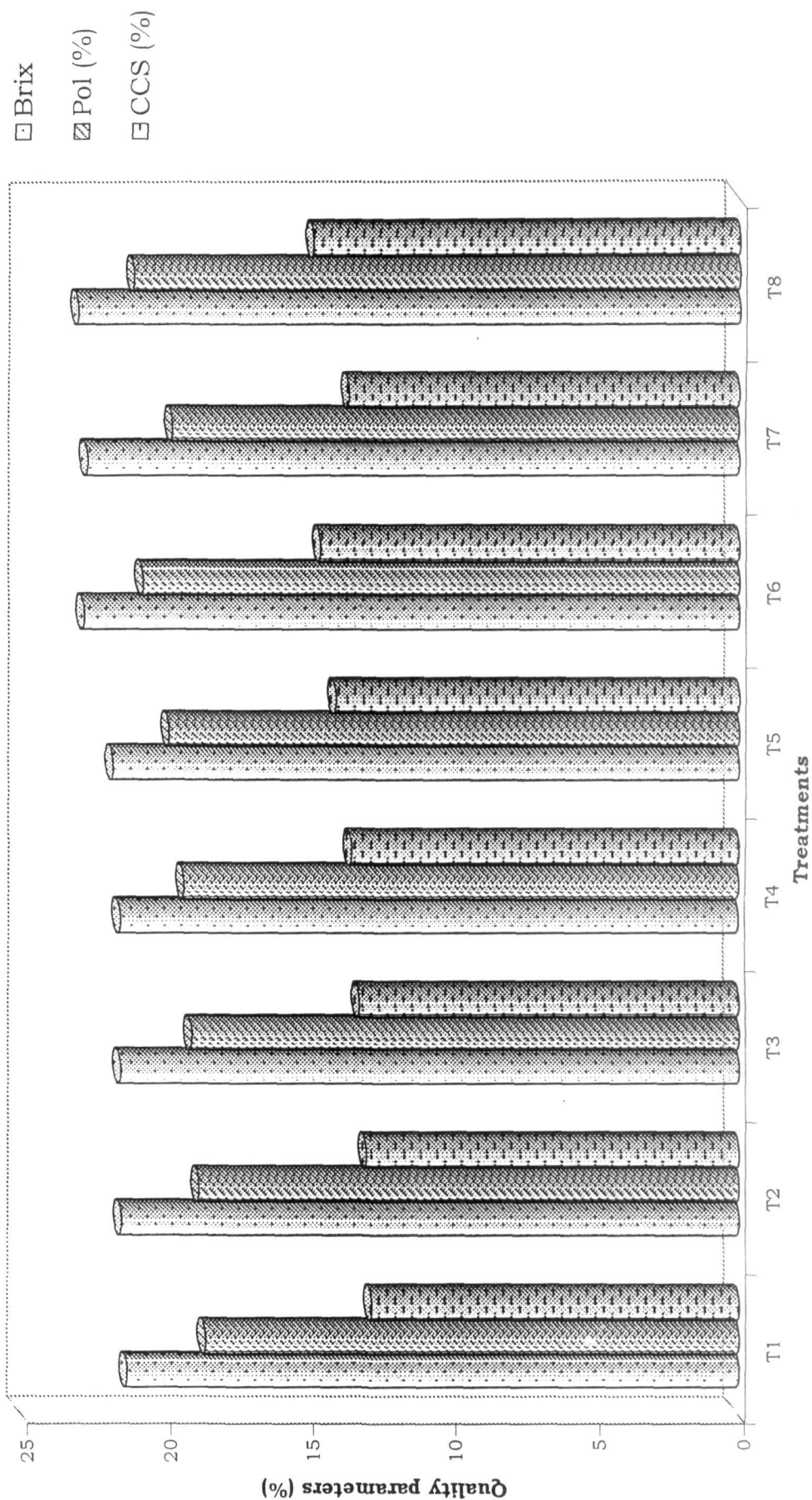


Fig. 8. Quality parameters of sugarcane as influenced by fertigation treatments

CCS per cent was not significantly influenced by treatments. But values of CCS per cent were higher in fertigation treatments. Fertigation of 125 per cent N and K (T₈) recorded higher CCS per cent of 14.88 than 12.76 per cent recorded at soil application of fertilizers with surface irrigation (T₁).

4.3.4 Purity (per cent)

Purity per cent values did not differ significantly due to fertigation treatments. However, all the fertigation treatments recorded higher values of purity per cent as compared to conventional methods of irrigation and fertilizer application. Fertigation of 125 per cent N and K (T₈) recorded higher purity per cent of 91.67 than (87.00) that recorded at soil application of fertilizers with surface irrigation (T₁).

4.3.5 Juice extraction percentage (Table 15)

Fertigation treatments significantly influenced the juice extraction percentage. All the fertigation treatments were significantly superior to conventional method of fertilizer application (T₁, T₂ and T₃). Fertigation of 125 per cent N and K recorded significantly higher juice extraction percentage (65.99) than surface irrigation with soil application of fertilizers (52.31%), but was on par with fertigation of 100 per cent N and K (64.55%) and fertigation of 100 per cent N (63.22%).

4.4 WATER USE STUDIES

4.4.1 Consumptive use of water (cm)

There was considerable variation in the total quantity of water applied through drip (78 cm) and surface irrigation (171.5 cm) exclusive of effective rainfall (29.5 cm).

Table 15. Purity (%) and extraction (%) of juice as influenced by different fertigation treatments

Treatments	Purity (%)	Extraction (%)
T ₁ - SI + soil application of recommended N splits	87.00	52.31
T ₂ - SI + N and K split	87.67	53.00
T ₃ - DI + soil application of N and K	88.67	57.68
T ₄ - Fertigation of 100% N in varied doses	90.00	62.48
T ₅ - Fertigation of 100% N in equal doses	90.67	63.22
T ₆ - Fertigation of 100% N and K	91.33	64.55
T ₇ - Fertigation of 75% N and K	87.00	62.25
T ₈ - Fertigation of 125% N and K	91.67	65.99
S.Em±	2.24	1.04
CD (0.05)	NS	3.17

SI = Surface irrigation
DI = Drip irrigation

4.4.2 Water use efficiency [WUE (t/ha-cm)]

The data regarding WUE (t/ha-cm) as influenced by different fertigation treatments are presented in Table 16.

The water use efficiency was higher under drip irrigation system (1.13 to 1.34 t/ha-cm) as compared to surface irrigation (0.53 to 0.54 t/ha-cm). The higher WUE of 1.34 t/ha-cm was recorded in fertigation of N and K 125 per cent N and K (T₈). While, lower WUE was observed in treatment with surface irrigation and soil application of fertilizers (0.53 t/ha).

The results indicated a saving of irrigation water to the extent of 46.52 per cent under drip irrigation compared to surface irrigation.

4.5 SPAD readings (Table 17)

SPAD readings of sugarcane varied significantly due to fertigation at 180 and 240 DAP and at harvest. But, it was non-significant at 120 DAP. Significantly higher SPAD reading of 33.77 at harvest was observed in fertigation of 100 per cent N in varied doses than soil application of fertilizer with surface irrigation (T₁ and T₂, 29.57 and 29.59, respectively) and drip irrigation (29.16).

4.6 NUTRIENT INDICES

Nutrient indices such as content of N, P and K concentrations in leaves were determined at harvest to assess the nutritional adequacy for crop growth. Total nutrient uptake by cane and post harvest soil available nutrients were also estimated to study the influence of fertigation.

Table 16. Water use of sugarcane as influenced by different fertigation treatments

Treatments	Irrigation water used (cm)	Effective rainfall (cm)	Consumptive use of water (cm)	Water use efficiency (t/ha-cm)	Percentage of water saving
T ₁ - SI + soil application of recommended N splits	171.5	29.5	201.0	0.53	
T ₂ - SI + N and K split	171.5	29.5	201.0	0.54	
T ₃ - DI + soil application of N and K	78.0	29.5	107.5	1.13	46.52
T ₄ - Fertigation of 100% N	78.0	29.5	107.5	1.24	46.52
T ₅ - Fertigation of 100% N	78.0	29.5	107.5	1.25	46.52
T ₆ - Fertigation of 100% N and K	78.0	29.5	107.5	1.32	46.52
T ₇ - Fertigation of 75% N and K	78.0	29.5	107.5	1.26	46.52
T ₈ - Fertigation of 125% N and K	78.0	29.5	107.5	1.34	46.52

SI = Surface irrigation
DI = Drip irrigation

Table 17. SPAD readings of sugarcane as influenced by different fertigation treatments

Treatments	120 DAP	180 DAP	240 DAP	At harvest
T ₁ - SI + soil application of recommended N splits	47.19	41.07	40.18	29.57
T ₂ - SI + N and K split	45.91	38.60	39.61	29.59
T ₃ - DI + soil application of N and K	43.53	39.40	39.30	29.16
T ₄ -Fertigation of 100% N in varied doses	43.80	44.50	44.03	33.77
T ₅ - Fertigation of 100% N in equal doses	44.50	44.43	43.45	33.53
T ₆ - Fertigation of 100% N and K	42.17	44.47	43.03	33.33
T ₇ - Fertigation of 75% N and K	43.83	44.17	43.95	33.59
T ₈ - Fertigation of 125% N and K	46.93	43.23	43.27	30.61
S.Em _±	1.65	0.79	0.48	1.01
CD (0.05)	NS	2.39	1.46	3.05

SI = Surface irrigation
 DI = Drip irrigation
 DAP = Days after planting

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ - SI + N and K split

T₃ - DI + soil application of N and K

T₄ - Fertigation of 100% N in varied doses

T₅ - Fertigation of 100% N in equal doses

T₆ - Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

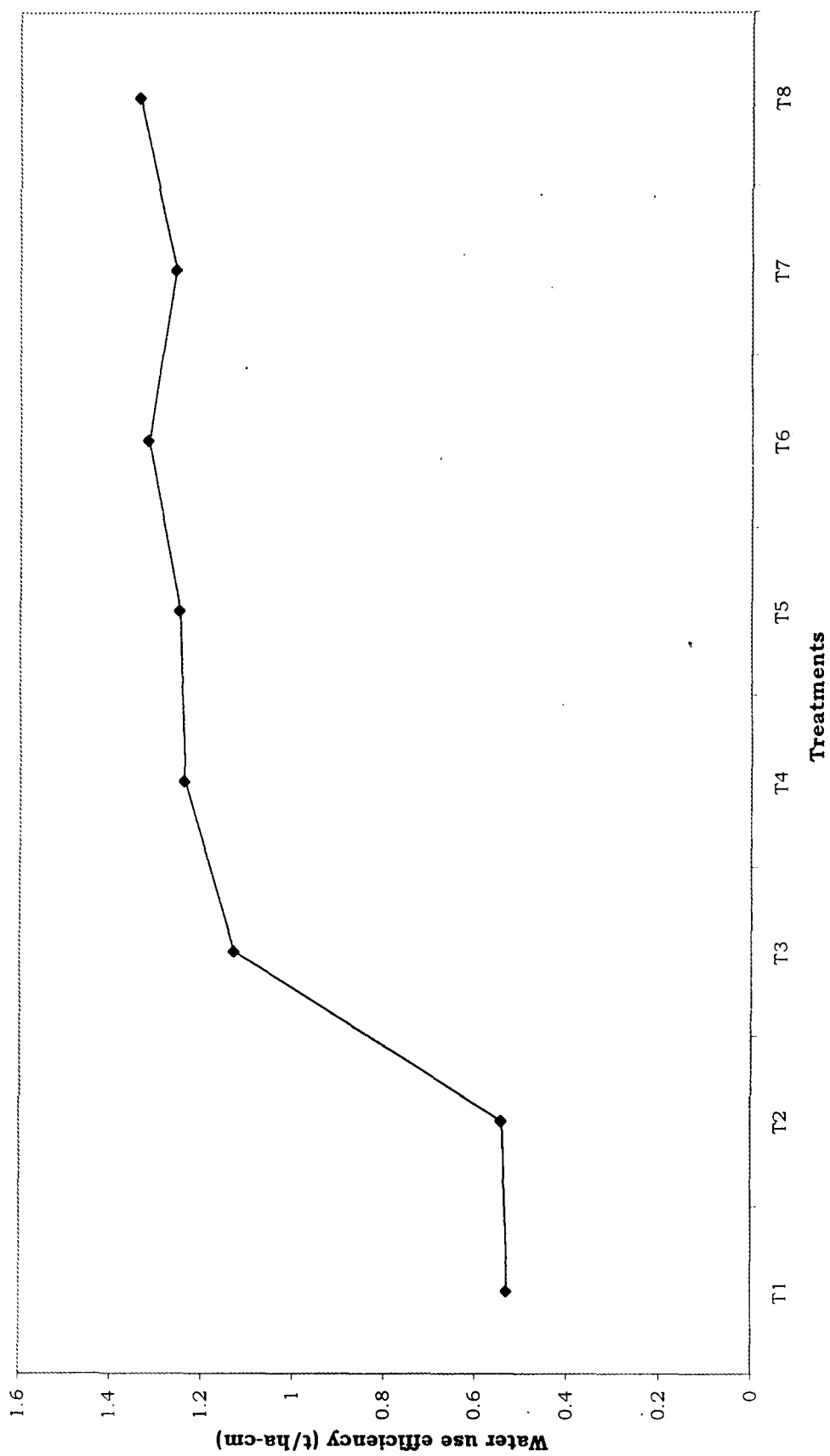


Fig. 9. Water use efficiency of sugarcane as influenced by fertigation treatments

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ - SI + N and K split

T₃ - DI + soil application of N and K

T₄ - Fertigation of 100% N in varied doses

T₅ - Fertigation of 100% N in equal doses

T₆ - Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

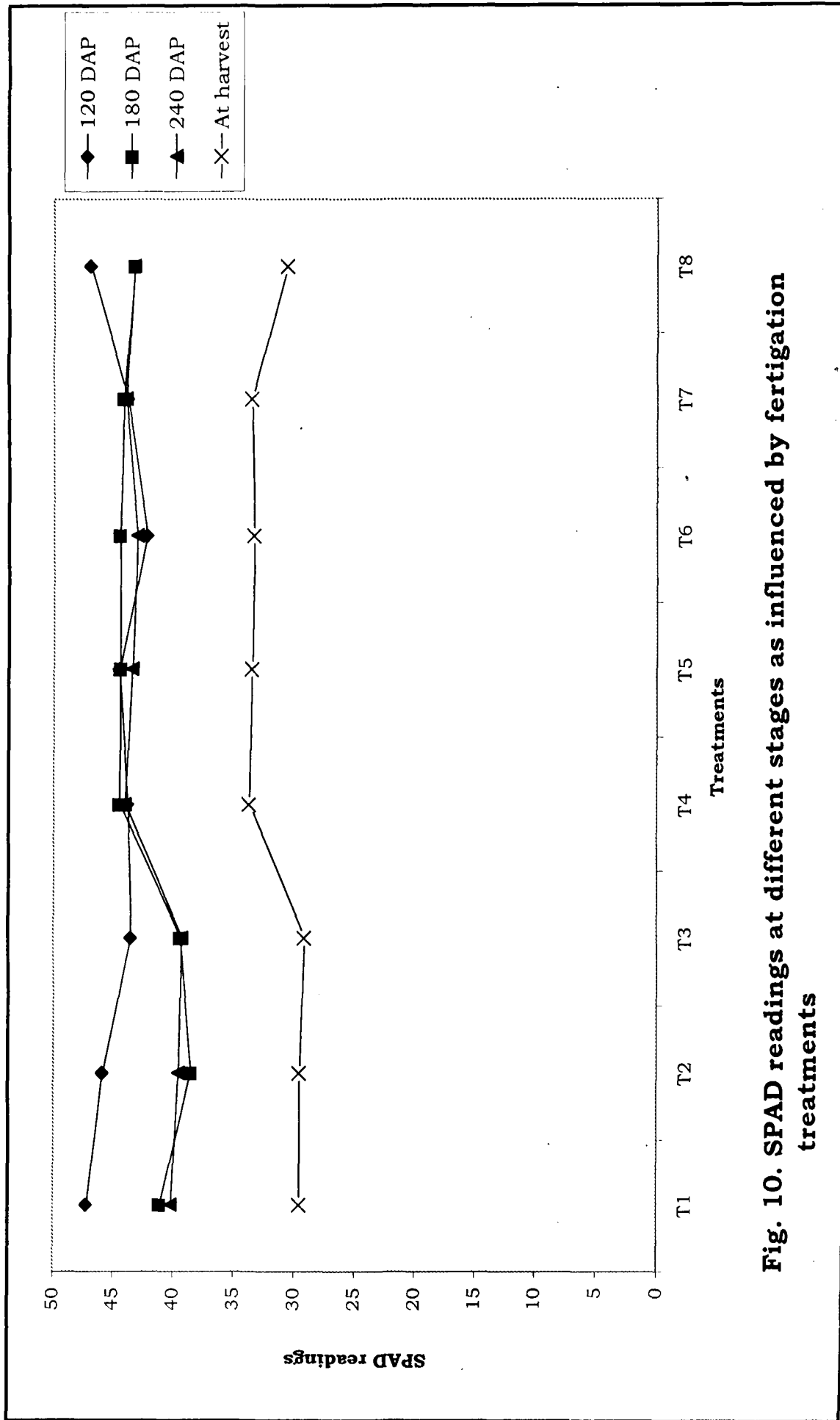


Fig. 10. SPAD readings at different stages as influenced by fertigation treatments

4.6.1 Leaf nitrogen content

The data on leaf nitrogen content as influenced by fertigation treatments are presented in Table 18.

Leaf nitrogen content at harvest was significantly influenced by fertigation treatments. All the fertigation treatments were superior to soil application. Leaf nitrogen content of 1.86 was noticed with fertigation of 125 per cent N and K (T₈) as compared to surface irrigation with soil application of fertilizers (1.71%).

4.6.2 Sheath phosphorus content

The data on sheath phosphorus content as influenced by fertigation treatments are presented in Table 18.

Sheath phosphorus content was significantly influenced by fertigation treatments. The higher sheath phosphorus content of 0.13 per cent was observed with fertigation of 125 per cent N and K, which was comparable with other fertigation treatments but significantly superior to soil application of fertilizers.

4.6.3 Sheath potassium content

The data on sheath potassium as influenced by fertigation treatments are presented in Table 18.

Sheath potassium content also exhibited the similar trend as observed with leaf nitrogen content. Fertigation of 125 per cent N and K recorded higher sheath potassium content of 2.86 per cent which was comparable with other fertigation treatments but significantly superior to

Table 18. Leaf nitrogen (%), sheath phosphorus (%) and sheath potassium (%) at harvest as influenced by different fertigation treatments

Treatments	Leaf nitrogen (%)	Sheath phosphorus (%)	Sheath potassium (%)
T ₁ - SI + soil application of recommended N splits	1.71	0.112	2.64
T ₂ - SI + N and K split	1.72	0.113	2.65
T ₃ - DI + soil application of N and K	1.77	0.119	2.72
T ₄ - Fertigation of 100% N in varied doses	1.83	0.124	2.80
T ₅ - Fertigation of 100% N in equal doses	1.83	0.124	2.81
T ₆ - Fertigation of 100% N and K	1.84	0.125	2.83
T ₇ - Fertigation of 75% N and K	1.82	0.123	2.82
T ₈ - Fertigation of 125% N and K	1.86	0.126	2.86
S.E.m _±	0.02	0.002	0.02
CD (0.05)	0.05	0.005	0.05

SI = Surface irrigation
DI = Drip irrigation

soil application of fertilizers. Surface irrigation with soil application of fertilizer recorded lower sheath potassium content of 2.64 per cent.

4.6.4 Nutrient uptake (kg/ha)

The data on nutrient uptake by sugar cane as influenced by different fertigation treatments are presented in Table 19.

The total N, P and K uptake by cane at harvest were estimated. Generally, higher uptake of nutrients was recorded under fertigation system. Fertigating the cane at 125 per cent N and K (T₈) resulted in uptake of 221.75, 60.70 and 316.33 kg N, P₂O₅ and K₂O per ha, respectively. The results clearly indicated an increased uptake of all nutrients with increased levels of fertilizers from 75 per cent to 125 per cent recommended doses. All the fertigation treatments recorded significantly higher nutrient uptake than soil application of fertilizers. Surface irrigation with soil application of fertilizers recorded lower nutrient uptake of 118.27, 33.98 and 178.71 kg N, P₂O₅ and K₂O per ha, respectively.

4.6.5 Post-harvest soil nutrient status (Table 20)

Assessment of post-harvest soil nutrient status for N, P and K nutrients indicated a declining trend. Soil application of fertilizers with surface irrigation (T₁) resulted in higher status of N, P and K in the soil (264.78, 17.97 and 272.50 kg/ha) when compared to fertigation treatments. The lower available N, P and K nutrient content was recorded with fertigation of 75 per cent N and K (T₇) (239.81, 13.88 and 208.85 kg/ha).

Table 19. Uptake of nitrogen, phosphorus and potassium (kg/ha) as influenced by different fertigation treatments

Treatments .	Nitrogen	Phosphorus	Potassium
T ₁ - SI + soil application of recommended N splits	118.27	33.98	178.71
T ₂ - SI + N and K split	127.71	38.04	188.48
T ₃ - DI + soil application of N and K	150.57	46.24	212.08
T ₄ - Fertigation of 100% N in varied doses	194.11	54.41	273.88
T ₅ - Fertigation of 100% N in equal doses	196.88	56.27	274.68
T ₆ - Fertigation of 100% N and K	209.15	59.42	291.32
T ₇ - Fertigation of 75% N and K	191.15	53.95	276.58
T ₈ - Fertigation of 125% N and K	221.75	60.70	316.33
S.Em _±	4.65	1.04	4.95
CD (0.05)	14.12	3.16	15.02

SI = Surface irrigation

DI = Drip irrigation

Table 20. Post-harvest nutrient status (kg/ha) of soil as influenced by different fertigation treatments

Treatments	Nitrogen	Phosphorus	Potassium
T ₁ - SI + soil application of recommended N splits	264.78	17.97	272.50
T ₂ - SI + N and K split	262.71	17.60	270.94
T ₃ - DI + soil application of N and K	262.62	16.98	270.25
T ₄ - Fertigation of 100% N in varied doses	245.59	14.41	211.25
T ₅ - Fertigation of 100% N in equal doses	246.28	14.20	215.24
T ₆ - Fertigation of 100% N and K	250.51	14.16	218.50
T ₇ - Fertigation of 75% N and K	239.81	13.88	208.85
T ₈ - Fertigation of 125% N and K	259.89	15.04	232.62
S.E.m _±	3.68	0.78	6.65
CD (0.05)	11.17	2.365	20.17

SI = Surface irrigation

DI = Drip irrigation

LEGEND

T₁ - SI + soil application of recommended N splits

T₂ - SI + N and K split

T₃ - DI + soil application of N and K

T₄ - Fertigation of 100% N in varied doses

T₅ - Fertigation of 100% N in equal doses

T₆ - Fertigation of 100% N and K

T₇ - Fertigation of 75% N and K

T₈ - Fertigation of 125% N and K

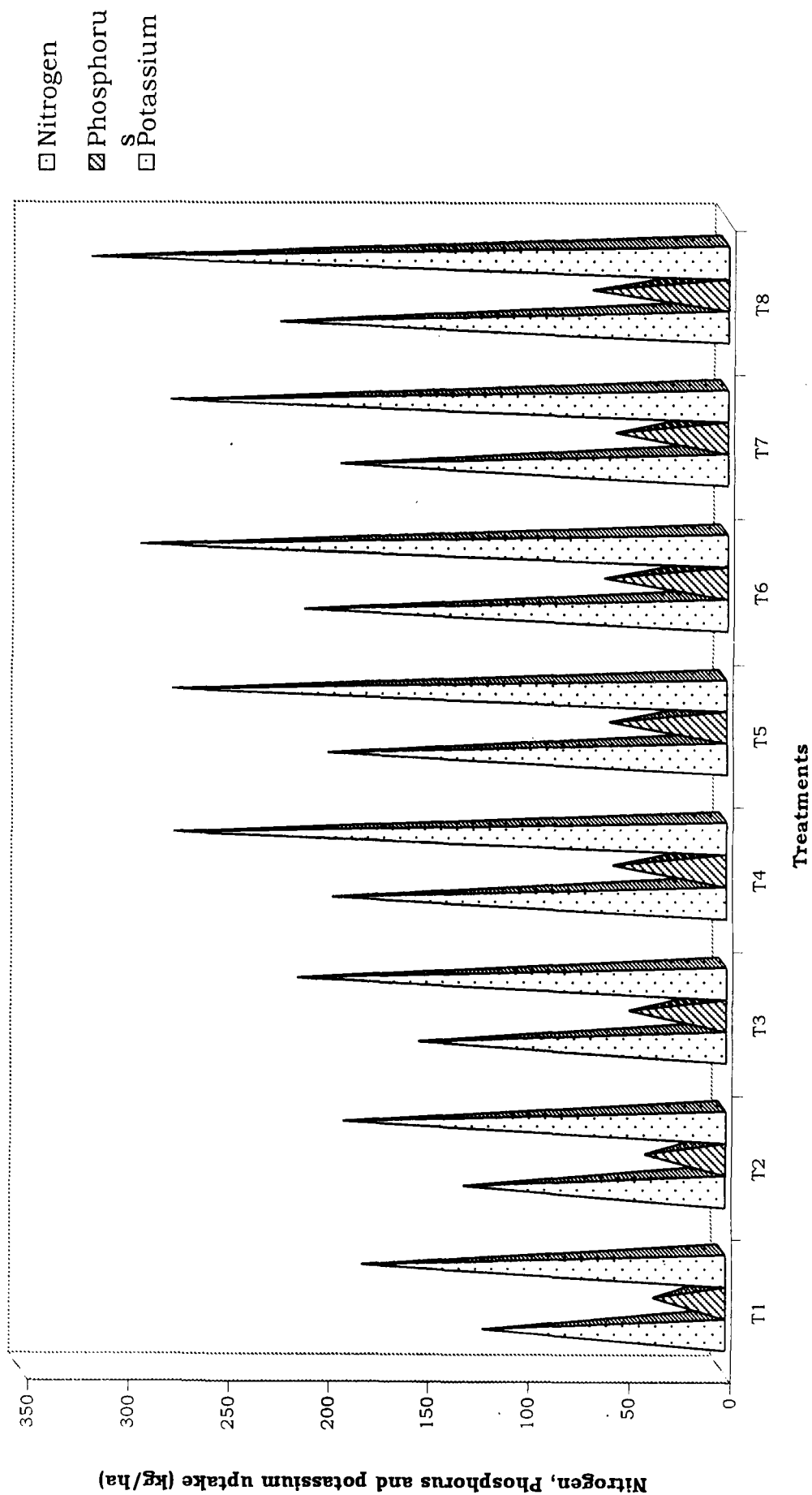


Fig. 11. Nutrient uptake by sugarcane at harvest as influenced by fertilization treatments

4.7 ECONOMICS

The data on economics of fertigation treatments are presented in Table 21.

All the fertigation treatments recorded higher gross and net returns compared to conventional fertilizer application. Fertigation of 125 per cent N and K recorded higher gross returns (Rs. 1,14,998/ha) while, net returns were higher with fertigation of 100 per cent N and K (Rs. 41,785/ha). Gross and net returns were lower with surface irrigation and soil application of fertilizers (Rs. 85,184/ha and Rs. 27,800/ha). Drip irrigation with soil application of fertilizers recorded higher gross and net returns than T₁ and T₂ but was inferior to all fertigation treatments. Higher B:C ratio of 1.59 was noticed in treatment with fertigation of 100 and 75 per cent N and K, whereas lowest (1.47) was noticed in treatment T₈.

Return per unit of water used (Rs/cm) was higher in all fertigation treatments compared to conventional fertilizer application. Higher returns per unit of water used (Rs.1069.63) was noticed in treatment receiving 125 per cent N and K through drip (T₈). Lower returns per unit of water used (Rs.423.80) was noticed in treatment with surface irrigation and soil application of fertilizer (T₁). Drip irrigation with soil application of fertilizers recorded higher returns per unit of water used (Rs.920.49) over surface irrigation with soil application of fertilizers (T₁ and T₂) and inferior to fertigation treatments

Table 21. Economics of sugarcane as influenced by fertigation

Treatments	Yield (t/ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit cost ratio	Returns/ unit of water used (Rs./cm)
T ₁ - SI + soil application of recommended N splits	106.48	57384	85184	27800	1.48	423.80
T ₂ - SI + N and K split	109.32	58784	87456	28674	1.49	435.10
T ₃ - DI + soil application of N and K	121.18	66024	98944	32920	1.50	920.49
T ₄ -Fertigation of 100% N	132.98	70176	106384	36208	1.52	989.61
T ₅ - Fertigation of 100% N	134.10	70333	107280	36947	1.53	997.95
T ₆ - Fertigation of 100% N and K	141.43	71359	113144	41785	1.59	1052.50
T ₇ - Fertigation of 75% N and K	135.71	68348	108568	40220	1.59	1009.93
T ₈ - Fertigation of 125% N and K	143.74	78165	114998	36827	1.47	1069.63

SI = Surface irrigation
DI = Drip irrigation

Discussion

V. DISCUSSION

The results obtained from the field experiments conducted at Agricultural Research Station, Arabhavi, during 2001-2002 with an object to study the response of sugarcane to fertigation are discussed in this chapter.

5.1 EFFECT OF FERTIGATION ON GROWTH AND YIELD OF SUGARCANE

Sugarcane is a tropical crop requiring warm humid weather for its good growth and productivity. Temperature ranging from 20°C to 35°C is ideal for optimum growth. Besides nutrients, temperature, light and moisture either through irrigation or as rainfall are the principal factors that control cane growth. Warm summer growing season with adequate rainfall during the active growing phases and fairly dry sunny weather with moderate relative humidity during maturity and ripening phase are the optimum conditions for high cane and sugar yields (Humbert, 1968).

The data on climatic parameters such as rainfall, maximum and minimum temperatures and relative humidity of the ARS, Arabhavi are presented in Table 2. Temperature and relative humidity were optimum during the crop growth whereas rainfall was less than the normal rainfall of that region and distribution was also not good. This affected crop growth to some extent. There was no incident of major pests and diseases during the season.

Fertigation of 100 and 125 per cent N and K recorded higher cane yield of 141.43 and 143.43 t per ha, respectively. Similar results were obtained by Shinde *et al.* (2000) and Bhoi *et al.* (2000).

The increase in cane yield compared to control was 25.92 per cent at fertigation of 125 per cent N and K and 24.34 per cent at fertigation of 100 per cent N and K. In general, the cane yields were higher under fertigation irrespective of fertilizer level compared to soil application of fertilizers. Fertigation of 75 per cent of N and K recorded cane yield of 135.71 t per ha which was 21.54 per cent higher than conventional method of fertilizer application with surface irrigation and 10.71 per cent higher than soil application of fertilizers with drip irrigation.

The cane yield (135.71 t/ha) under fertigation of 75 per cent N and K was comparable with 100 per cent of N and K (141.43 t/ha) indicating the possibility of saving of fertilizers to the extent of 25 per cent. These results are in conformity with those of Hapase *et al.* (1993b), Shinde *et al.* (1998), Ng Kee Kwong *et al.* (1999) and Singandhupe and Brahmanand (2001) who reported 25-30 per cent saving of fertilizers due to fertigation.

Split application of potassium resulted in marginal increase in cane yield. Application of potassium in splits through drip irrigation resulted in 5.2 per cent higher yield than only nitrogen through drip compared to only 2.6 per cent increase in yield with surface irrigation and N applied in splits. Similar results have been reported earlier (Anon., 2000).

The increase in cane yield under fertigation system was obviously due to higher efficiency and easy availability of plant nutrients and application of water and nutrients into active root zone of the crop, when

compared to soil application of fertilizers with surface and drip irrigation. This favourable environment resulted in better and earlier conversion of tillers into millable canes (Table 11) and the early vigour was maintained throughout the crop growth period due to the continuous availability of nutrients and resulted in increased cane yield (Table 13). The lower yield under conventional application of fertilizer was mainly due to lower availability of required nutrients and water that resulted in lower number of millable canes (Table 13).

The sugar yield is a function of cane yield and CCS per cent and hence trend was similar as in cane yield. Fertigation of 125 per cent N and K (21.88 t/ha) and 100 per cent N and K (20.65 t/ha) increased the sugar yield to an extent of 38.21 and 34.53 per cent, respectively over soil application of fertilizers. Fertigation of 75 per cent N and K recorded sugar yield of 18.46 t/ha, which was comparable with fertigation of 100 per cent of N and K and was 26.76 per cent higher than soil application of fertilizers.

The increased sugar yield may also be attributed to improved juice characters like brix, pol per cent, purity per cent and CCS per cent due to production of uniform millable canes in these treatments. The increase in sugar yield was mainly due to higher cane yield recorded in fertigation treatments.

In this study cane sprouting at 40 DAP was 72.00 to 78.67 per cent were recorded at 40 DAP. In general, sprouting per cent was higher when crop was irrigated through drip system along with fertigation. Fertigation treatments did not influence the sprouting per cent because the fertigation was scheduled from 30 DAP. The higher sprouting percentage (Table 3)



Plate 1. Fertigation of 100% 'N'



Plate 2. Fertigation of 75% 'N' and 'K'



Plate 3. Surface Irrigation + 'N' Recommended Splits

was recorded in fertigation of 100 per cent N. The higher sprouting percentage under drip system was mainly due to the continuous supply of water near the sett region, which helped to increase the sett moisture content. Increased sett moisture is one of the pre-requisites for getting higher sprouting percentage. The results are in conformity with the findings of Dilip and Mandakini (1993) who reported that higher sprouting percentage under micro-irrigation system and lower sprouting percentage under conventional method of irrigation.

The tiller production was higher in fertigation of 125 per cent N and K (15.03/plant). The increase in tiller production in fertigation treatments (14.04 to 15.03/plant) over soil application of fertilizers with surface irrigation (9.81/plant) was in the range of 30.13 to 34.70 per cent. The increased tiller production under fertigation system was mainly due to continuous supply of required quantity of water and nutrients. The reduced tiller production in soil application of fertilizers with surface irrigation (9.81 and 10.34/plant) and drip irrigation (11.34/plant) was mainly due to inadequate supply of required plant nutrients. Increased tiller production was noticed with increased level of fertilizers under fertigation. This finding is in conformity with earlier findings of Shinde *et al.* (2000) who reported that fertigation of sugarcane resulted in more number of tillers.

The results of the experiment clearly indicated a positive response between growth attributing characters such as plant height, dry matter production and leaf area index and fertigation. Higher cane length (288.00 cm), dry matter production (Table 10) (403.61g/plant) and leaf area index (Table 9) (6.34) were recorded at fertigation of 125 per cent N

and K. Fertigation of 100 per cent N and K recorded on par cane length (287.67 cm), dry matter production (396.74 g) and leaf area index (6.28) with fertigation of 125 per cent N and K and was superior over soil application of fertilizers with surface and drip irrigation methods. Superior plant characters were mainly due to the enhanced availability of nutrients by the continuous supply of nutrients through drip irrigation system upto 240 DAP along with required quantity of water needed for the crop growth. Similar results were also obtained by Ng Kee Kwong *et al.* (1999), Shinde *et al.* (2000) and Bhoi *et al.* (2001).

Higher single cane weight of 1.98 kg under fertigation of 125 per cent of N and K than 1.13 kg was recorded under soil application of fertilizers with surface irrigation. Similarly, all the fertigation treatments resulted in higher single cane weight. Increased girth, length and number of internodes were observed in fertigation treatments which reflected in higher single cane weight. Similar observations of increased individual cane weight, girth and number of internodes under fertigation system were reported by Bhoi *et al.* (1999) and Bhoi *et al.* (2001).

Number of millable cane is one of the most important characters in cane cultivation deciding the final yield. The higher number of millable canes of 86918 and 85994 per hectare were observed at 125 per cent N and K and 100 per cent N and K. The result show that the increase in number of millable canes ranged from 11.39 to 17.89 per cent under fertigation system compared to soil application of fertilizers with surface irrigation. The result also indicated a higher number of millable canes with increase in level of fertilizers. The higher number of millable canes (Table 11) under fertigation was mainly due to the enhanced supply of



Plate 4. Fertilization of 125% 'N' and 'K'



Plate 5. Fertilization of 75% 'N' and 'K'



Plate 6. Cane Length in Different Treatments

plant nutrients and continuous availability of water to the crop without stress.

5.2 EFFECT OF FERTIGATION ON QUALITY OF SUGARCANE JUICE

Juice quality parameters such as brix, pol per cent, purity per cent and CCS per cent were not affected by fertigation system. Fertigation treatments recorded brix, pol per cent, purity per cent and CCS per cent in the range of 21.59 to 23.08, 19.37 to 21.15 per cent, 90.00 to 91.67 per cent and 13.49 to 14.88 per cent, respectively as against in soil application. These results are identical with the results obtained by Deshmukh *et al.* (1996), Shinde *et al.* (1998), Bhoi *et al.* (1999) and Bhoi *et al.* (2001). However, Bhoi *et al.* (2000) reported slight improvement in quality parameters when fertigation of N was scheduled upto 175 DAP.

5.3 EFFECT FERTIGATION ON WATER USE EFFICIENCY

Water use efficiency studies clearly indicated that fertigation resulted in higher water use efficiency (1.24 to 1.34 t per ha-cm), which was nearly two times higher than that of soil application of fertilizers with surface irrigation (0.53 t per ha-cm) indicating a saving of 46.52 per cent of irrigation water. This is in conformity with the findings of Hapase *et al.* (1993a), Anon. (1996) Shinde *et al.* (1999), and Bhoi *et al.* (2000).

5.4 EFFECT OF FERTIGATION ON SPAD READINGS

SPAD readings were higher in fertigation of 100 per cent N in varied doses at initial stages of crop growth. SPAD readings were non-significant and higher in soil applied fertilizer treatments, whereas, at later stages the SPAD readings were higher in fertigation treatments. This was mainly due

to continuous supply of nitrogen upto 240 DAP which helped to keep plant greener which is directly related to SPAD readings.

5.5 EFFECT OF FERTIGATION ON NUTRIENT UPTAKE

The optimum and critical level of nutrient indices like leaf nitrogen (1.85), sheath phosphorus (0.08) and sheath potassium (2.25) for favourable cane yield were arrived by Clements (1980). Generally, all the nutrient indices shows a positive increase under increased level of fertilizers through drip.

Fertigation recorded higher nutrient uptake than surface irrigation with soil application of fertilizers. Among fertigation treatments higher uptake of N, P and K was recorded under fertigation of 125 per cent of N and K (221.75, 65.70 and 316.33 kg N, P_2O_5 and K_2O /ha, respectively). Generally, the nutrient uptake under fertigation system was higher under increased level of fertilizer application. The increased uptake under fertigation that too at higher fertilizer level was the result of increased biomass production due to continuous availability of plant nutrients. This increase in uptake of nutrients was also due to the split application of nutrient upto 240 DAP, which might have reduced the losses and eventually making them available to the crop at all the stages of crop growth continuously. This is in conformity with findings of Kittad *et al.* (1995) and Bangar and Chaudhari (2001).

5.5.1 Post-harvest Soil nutrient status

The soil available nutrient status indicated a reverse trend to that of nutrient uptake pattern. Higher soil available N, P and K status of

264.78, 17.97 and 272.57 kg per ha was recorded under surface irrigation method.

Among fertigation treatments, soil available nutrient status was relatively higher in fertigation of 125 per cent N and K. This was due to higher level of fertilizer application which was probably more than the crop requirement. The lower available NPK status under fertigation was mainly due to greater uptake of NPK consequently resulted in higher cane yield.

5.6 ECONOMICS OF FERTIGATION

Fertigation of 100 per cent of N and K resulted in higher net return of Rs. 41,785/-. This was 33.47 per cent higher compared to conventional method of soil application of fertilizers with surface irrigation (Rs. 27,800/-). The next best economically viable treatment was the fertigation of 75 per cent N and K, which recorded a net return of Rs. 40,220/-. Fertigation of 75 per cent and 100 per cent N and K both recorded higher B:C ratio of 1.59. The increase in net return and B:C ratio in the above said treatments were mainly due to the increase in cane yield. This is conformity with the findings of Bhoi *et al.* (2001) and Bangar and Chaudhari (2001). Although fertigation of 125 per cent of N and K recorded highest cane yield and gross return, but the net return and B:C ratio were lower. This was attributed to the higher cost of fertilizers in this treatments.

RESULTS OF PRACTICAL UTILITY

1. Fertigation of 75 per cent N and K produces on par cane and sugar yield as fertigation of 100 per cent N and K indicating 25 per cent saving in fertilizers.
2. Split application of nitrogen and potassium through drip upto 240 DAP did not affect the quality parameters, but has favourable effect on yield.
3. Fertigation of N and K was found to significantly enhance the nutrient uptake by the crop.
4. Fertigation of 100 per cent N and K gave higher net returns which was closely followed by fertigation 75 per cent of N and K.

FUTURE LINE OF WORK

From the present study, the following thrust areas were recognised for future work.

1. The phenomenon of early maturity of sugarcane under drip and fertigation system needs to test verified.
2. Dose of application of fertilizers as per the growth stages need to be studied.
3. Standardisation of suitable planting technique under fertigation.

Summary

VI. SUMMARY

A field investigation was carried out at Agricultural Research Station, Arabhavi, Belgaum district, Karnataka during 2001-02 to study the response of sugarcane to fertigation. The experiment was laid out in randomized complete block design, replicated thrice on medium black soil with the following treatments.

1. Surface irrigation (SI) + soil application of recommended dose of N and K @ 250 and 185 kg/ha, respectively. Split application of only N @ 10, 20, 30 and 40 per cent of RDN at planting, 6, 10 and 14 WAP, respectively.
2. SI + soil application of recommended dose of N and K @ 250 and 185 kg/ha, respectively. Split application of both N and K @ 10, 20, 30 and 40 per cent at planting 6, 10 and 14 WAP, respectively.
3. Drip irrigation + soil application of recommended dose of N and K @ 250 and 185 kg/ha, respectively, split application of only N @ 10, 20, 30 and 40 per cent of RDN at planting, 6, 10 and 14 WAP, respectively.
4. Fertigation of 10 per cent N in equal splits during 30-60 DAP @ 5 kg/ha/time at 6 days interval + 20 per cent N in equal splits during 60-120 days @ 5 kg/ha/time at 6 days interval + 30 per cent N in equal splits during 120-180 days @ 7.5 kg/ha/time at 6 days interval + 40 per cent N in equal splits during 180-240 days @ 10 kg/ha/time at 6 days interval + soil application of K.
5. Fertigation of 250 kg N @ 7.14 kg/ha/time at 6 days interval in equal splits upto 240 DAP + soil application of K.

6. Fertigation of 250 kg N @ 7.14 kg/ha/time and 185 kg K @ 5.2 kg/ha/time at 6 days interval in equal splits up to 240 DAP.
7. Fertigation of 75 per cent of recommended dose of N @ 5.35 kg/ha/time and K @ 3.90 kg/ha/time at 6 days interval in equal splits up to 240 DAP.
8. Fertigation of 125 per cent of recommended dose of N @ 8.93 kg/ha/time and K @ 6.60 kg/ha/time at 6 days interval up to 240 DAP.

In all the treatments recommended dose of P_2O_5 (75 kg/ha) was applied as soil application at planting.

The conclusions and inferences drawn from the observations of the study are summarised below.

Sprouting of cane was higher under drip and fertigation system (78.67%) than surface irrigation with soil application of fertilizers (72%).

Higher number of tiller production was noticed in fertigation of 75 per cent N and K (14.18/plant) than soil application of fertilizers with surface irrigation (9.81/plant).

Fertigation treatment significantly influenced growth parameters such as cane length, number, girth and length of internodes. Fertigation of 75 per cent N and K recorded higher values of these parameters, 264.00, 21.47, 11.78 and 14.57 cm, respectively. Whereas soil application of fertilizers resulted in reduced cane length, number, girth and length of internodes (234.33, 16.33, 9.77 and 12.00 cm, respectively).

Cane physiological parameters such as dry matter production and leaf area index were higher (390.89 g/plant and 5.94, respectively) under fertigation at 75 per cent N and K. Whereas soil application of fertilizers recorded lower dry matter production and leaf area index of 368.24 g/plant and 4.49, respectively.

Fertigation treatments significantly recorded higher yield attributes such as single cane weight and number of millable canes than soil application of fertilizers. Fertigation of 75 per cent N and K recorded higher single weight and number of millable canes of 1.75 kg and 80541 per ha, respectively.

Fertigation significantly increased the cane and sugar yield of 135.71 and 18.46 t per ha, respectively with fertigation of 75 per cent of N and K. Soil application of fertilizers with surface and drip irrigation resulted in lower yields (106.48 and 13.52 t/ha of cane and sugar yields, respectively).

Cane juice quality parameters like juice brix, pol per cent and CCS per cent did not differ significantly due to fertigation treatments. Fertigation of 75 per cent N and K recorded higher values of brix, pol per cent and CCS per cent of 22.75, 19.79 and 13.60, respectively. Whereas, surface irrigation with soil application of fertilizers resulted in lower values of these parameters (21.31, 18.58 and 12.76, respectively)

Leaf nitrogen, sheath phosphorus and potassium contents were higher in fertigation treatments. Fertigation of 75 per cent N and K recorded higher N, P and K content of 1.82 to 0.123 and 2.82, respectively.

Soil application of fertilizers resulted in low nutrient contents of 1.71, 0.112 and 2.64 per cent N, P and K, respectively.

Fertigation treatments recorded higher nutrient uptake than soil application of fertilizers. Nutrient uptake at harvest was higher in fertigation of 75 per cent N and K (191.15, 53.95 and 276.58 kg/ha N, P and K, respectively). Reduced uptake was noticed in soil application of fertilizers (118.27, 33.98 and 178.71 kg/ha N, P and K, respectively).

Higher water use efficiency was noticed under fertigation than soil application of fertilizers. Fertigation of 75 per cent N and K recorded higher water use efficiency of 1.26 t per ha-cm, whereas lower water use efficiency 0.53 t per ha-cm was noticed surface irrigation with soil application of fertilizers.

Fertigation of 100 per cent N and K resulted in higher net returns (Rs. 41,785/-), closely followed by fertigation of 75 per cent N and K (Rs. 40,220/-). Fertigation of 100 and 75 per cent N and K recorded a B:C ratio of 1.59, whereas soil application of fertilizers resulted in lower net returns (Rs. 27,800/-) and B:C ratio (1.48).

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Appendices

APPENDIX I. Quantity of water delivered through drip

Month	Daily PE (cm)	Crop coefficient (cf)	Quantity of water applied for each plot (l/pl/day)	Amount of H ₂ O for 43.2 m ² (l/day)	Amount for entire month in litres
April	9.73	0.60	0.97	155.0	3255
May	10.09	0.65	1.10	170.0	5456
June	7.36	0.90	1.10	176.0	5196
July	5.18	0.90	0.77	123.0	2583
August	4.69	1.10	0.86	137.6	3440
September	4.83	1.10	0.88	141.8	2410
October	5.19	1.15	0.99	158.4	3088
November	4.66	1.15	0.89	142.4	4272
December	4.47	1.00	0.82	131.2	4067
Total					33767

Pan factor (Pf) = 0.88

Appendix II. Cost of cultivation of sugarcane

Items of inputs	Input unit	Quantity/ha	Input price (Rs./unit)	Total cost (Rs./ha)
I Operational cost				
Human labour				
Male	Man	82 (62)	40	3280 (2480)
Female	days	148 (128)	30	4400 (3800)
Total		230 (190)	-	7680 (6880)
II Bullock pair	Days	10	200	2000
III Tractor	Hours	29	200	5800
IV Planting material	Mt	8	900	7200
V Fertilizers				
N		250	10.23	2558
P	Kg	75	20.16	1512
K		185	6.88	1272
VI Manures	Mt	25	300	7500
VII Insecticide	Litres	3	195	585
VIII Weedicide	Kg	3	490	1470
IX Irrigation	Ha	1	600	600
X Land revenue, cess and Tax	Rs.	-	2800	2800
XI Harvest and transport	Tonnes	-	140	-
Treatments	Yield (t/ha)	Rs./ha		
T ₁	106.47	14907/-		
T ₂	109.32	15305/-		
T ₃	121.18	16965/-		
T ₄	132.98	18617/-		
T ₅	134.10	18774/-		
T ₆	141.43	19800/-		
T ₇	135.71	18999/-		
T ₈	143.74	20124/-		

Figures in parentheses indicate the cost of fertigation treatment

- Cost of 75 per cent of RDF - Rs. 4007/-
- Cost of 125 per cent RDF - Rs. 6677/-

Appendix III. Cost of drip unit per ha

Sl. No.	Particulars	Quantity (ha)	Unit price (Rs.)	Amount (Rs.)
1.	Main pipe line 2 ½" (20 ft)	15 Nos.	200	3000
2.	Sub-main 2" (20 ft)	25 Nos.	168	4200
3.	Ventury assembly	1 set	1350	1350
4.	A-3 screen filter	1 set	2100	2100
5.	Control valve	5 Nos.	525	2625
6.	Fitting charge	-	-	1000
Total				14275
7.	12 mm C-1 laterals	8000 mt	3.55	24850
8.	12 mm start connectors	130 Nos.	6.00	780
9.	12 mm end cap	130 Nos.	2.00	260
10.	4-LPH drippers	7500	1.60	12000
Total				37890
11.	Electricity charge			1500
Grand total				53665

Fixed cost (Rs./ha)	37890*	14275**
a. Life (years)	6	20
b. Depreciation	6315	714
c. Interest (12%)	758	86
d. Repairs and maintenance (5%)	1895	714
Total (b+c+d)		10482/-
Electricity charge		1500/-
Grand total		11982/-

* Cost laterals, drippers, connectors, end cap

** Cost of mains, sub-mains, ventury, filter, valves etc.



EFFECT OF FERTIGATION ON YIELD, QUALITY AND NUTRIENT UPTAKE OF SUGARCANE

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ABSTRACT

A field experiment was conducted to study the effect of fertigation on yield, quality and nutrient uptake of sugarcane (CoC-671) in medium black soil during 2001-02, at Agricultural Research Station, Arabhavi, Gokak taluk of Belgaum district. The experiment consisted of eight treatments with three replications and was laid out in RBD.

The cane (141.43 t/ha) and sugar (20.65 t/ha) yields were increased by 24.34 and 34.53 per cent due to fertigation when compared to soil application of fertilizer with surface irrigation (106.48 t/ha). Further, the cane and sugar yields were increased with an increase in fertilizer level and were maximum with 125 per cent level of fertigation. Fertigation of 75 per cent of recommended levels of N and K recorded on par yield with that of 100 per cent N and K indicating a saving of fertilizer to the tune of 25 per cent. Similar trend was observed with respect to growth and yield attributes.

The juice quality parameters such as brix, pol per cent and CCS per cent did not differ significantly due to fertigation treatments.

The total quantity of water applied through drip was 107.5 cm as compared to 201.0 cm in surface irrigation resulting in 46.52 per cent water saving. The water use efficiency ranged between 1.24 to 1.34 tonnes per hectare cm in fertigation treatments as compared to 0.53 tonnes per hectare cm in surface method.

Fertigation resulted in significantly higher uptake of nutrients than soil application of fertilizers with surface irrigation. Further, the uptake of nutrients was increased with an increase in fertilizer level and was maximum with 125 per cent level of fertigation.

Fertigation of 100 per cent recommended levels of N and K resulted higher net returns of Rs. 41,785/-. This was 33.47 per cent higher compared to soil application of fertilizers with surface irrigation (Rs. 27,800/-). Fertigation of 75 and 100 per cent N and K both recorded higher B:C ratio of 1.59.