Modern Irrigation & Fertigation methodologies for higher yields in Sugarcane

Jain Irrigation Systems Ltd.,
Jalgaon

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JAIN GROUP

From a very humble beginning in 1963 as a Trading Company, Jain Group has blossomed into an Agriculture Infrastructure Company, second to none in the Country, by the sheer dint of invincible determination and dedication of a **Great Visionary Shri. Bhavarlal Hiralal Jain, the Founder Chairman of the Group, who has appropriately been awarded the "CRAWFORD REID MEMORIAL AWARD" by the IRRIGATION ASSOCIATION of USA,** for his significant achievements in promoting proper Irrigation Techniques and fostering major advancements in the Industry outside the United States.

Jain Irrigation Systems Ltd., the flagship company of the Group, is the pioneer and market leader in Micro Irrigation Industry in the Country and has covered over 4.5 lakhs acres of land under Drip Irrigation with over 45 different crops.

Jain Irrigation Systems Ltd., extended its activities into hi-tech agro related ventures like Tissue Culture Plants, Green House Construction, Water Soluble Solid/liquid fertilizers, Bio-pesticides and Bio-fertilizers. Conservation being the main thrust in the Company's activities, it went into the manufacture of Solar Water heating system as well as Eco-friendly PVC door/window profiles and PVC/ Polycarbonate/Acrylic sheets for various applications replacing wood.

As a forward integration, Jain Group, diversified into food processing and have two state-of-the-art plants with a capacity of 120 MT each per day(the largest in Asia) for processing vegetables and fruits. Jain Irrigation Systems Ltd., is the only Company in the Country to have a Research and Development farm spanning over 1000 acres of land which is the only one of its kind recognized by the Govt. of India in Private Sector for agriculture related activities and experiments on various agronomic and irrigation practices in line with International Practices.

The Company's main thrust is to totally modernize the Irrigation application practices in India with a view to improve the Quality, Production, Conservation and also to find a niche in the world export market for the Indian produce. With this in mind**, the Company today, is totally equipped to develop, virtually from Concept to Commissioning of Agro Irrigation Projects on any type and size of land anywhere within the Country or abroad, taking up the jobs on a turnkey basis to complete and hand over on a time bound schedule.**

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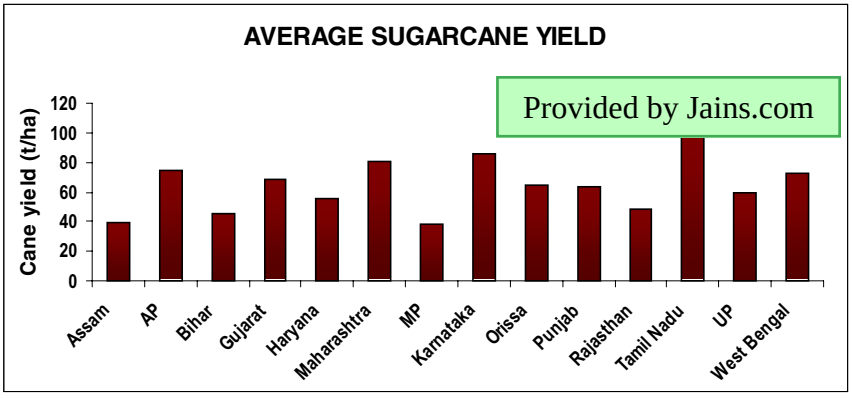
***Disclaimer :** The package of practices given in this booklet is based on limited experimental data and need not be applicable to all Sugarcane growing areas.Therefore, the company does not guarantee the production levels mentioned here in every location where the package is adopted.

INTRODUCTION

India is world's largest producer of sugar and sugarcane. Sugarcane is cultivated in about 4.09 million ha producing about 283 million t of cane with an average productivity 72.6 MT / ha. Of the several agricultural crops, Sugarcane is the most remunerative crop and has a very high economic biomass to total biomass ratio. Its requirements for water and fertilizer are equally very high. About 60% of cane in India is in the subtropical zone and 40% in tropical zone. The productivity varies significantly between these zones; it is 89 & 58 MT/ha, respectively.

In India area under Sugarcane is highest, 21.4 lakh ha in UP. The productivity of MP is lowest, 39.3 MT/ha and that of Tamilnadu is highest,134.2 MT / ha in the country. Except in Maharashtra, Sugarcane is grown with flood irrigation in all other states. productivity of cane is declining due to excess use of water & imbalanced fertiliser doses. The average yields of sugarcane in the major states are shown below. (Fig.1)



CONSTRAINTS FOR CANE YIELD AND PRODUCTIVITY

1) Non availability of high yielding varieties
2) Dearth of good quality seed
3) Improper water management
4) Use of imbalanced fertilize doses

5) Negligence in plant protection.

6) Low awareness among the farmers to use improved cultivation practices.

7) Poor attention to Ratoon crop

Sugarcane crop belongs to *Gramineae*, the grass family. It responds well to nutrition & water management. Sugarcane productivity can increase if appropriate irrigation & fertilization management is followed.

SOIL AS A MEDIUM FOR SUPPLYING, AIR, WATER AND NUTRIENTS

Crop stands in the field from 12 to 18 months. Sugarcane roots extends to 90 cm depth. Sugarcane grows extremely well in medium to heavy, well drained, soils of pH 7.5 to 8.5 and high organic matter content. Water logged soils and soils of poor drainage are not suitable. Growth of Sugarcane will be poor in light sandy soils. Gypsum, or sulphur can be used for soil reclamation of saline and / or alkaline soils.

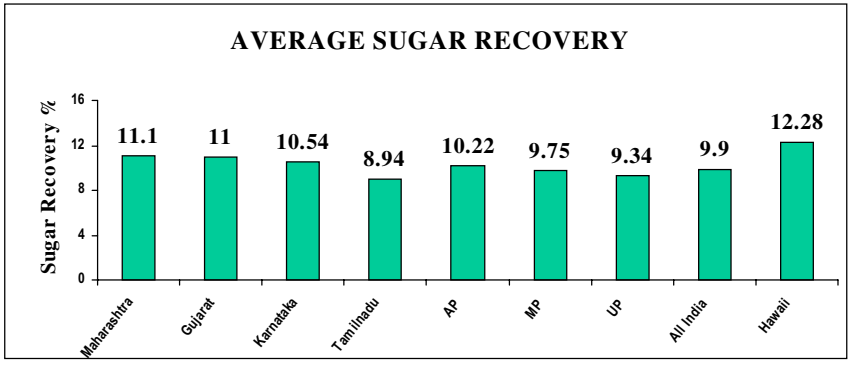
CLIMATIC ADAPTATION

Heat, humidity, and sunlight intensity play important role in Sugarcane germination, tillering, vegetative growth and maturity. Sugarcane grows well in humid & hot weather. For more tillers it requires a temperature regime of 30 to 35 oC. It requires humidity of 70% for more vegetative growth. Sugar conversion is more at lower temperatures. It needs a period of cool weather or a period of water stress for sucrose accumulation in the stems.

Sugarcane in India is grown from 8o N to 30o N latitude covering a wide range of climatic conditions and soils. Two distinct regions of cane cultivation are recognized; the tropical and subtropical. The tropical region is south of the Vindhyas and climatically best suited for sugarcane culture while the subtropical region, North of the Vindhyas experiences extremes of temperatures. Here the summer temperatures are very high and the winter temperatures are very low. The cane growing season is thus restricted at both ends. The shorter the growing season the lesser the yields and lower the sugar recovery.

The variation in average cane yield is very high (Fig. 1) with TN producing highest yield of the country and MP the lowest. Similarly the recovery rate is also variable (Fig. 2)

In TN, Karnataka, AP and Maharashtra the mean monthly temperatures are high while the variability in the mean monthly temperature is less. This factor is responsible for the higher yields of these states compared to other low yielding states.



Similarly, the mean minimum temperature and the relative temperature disparity (i.e. the difference between mean minimum and mean maximum taken over a month) are comparatively lower in Maharashtra and Gujarat during the ripening (maturity phase). This is why these two states achieve higher recoveries compared to other states. This will also explain why a state like TN which has the highest yield of cane records the lowest recovery %.

Those states recording a mean minimum temperature of 14-18oC and low relative humidity, 50-60% and a low daily mean temperature, 22-26oC during the ripening period gives highest recovery.

Land Preparation requirements for effective Drip Irrigation Management

Ploughing

Preparatory tillage is a very important operation in Sugarcane cultivation. Sugarcane roots penetrate upto 90 cm deep in the soil & hence for better growth of roots tillage has an important effect. Soil preparation must destroy the stumps of old canes and improve any bad physical soil characteristics or loss of structure

Furrow opening

Effect of climatic factors on sugar cane

	Air Temperature	Soil temperature	Water (rain or Irrigation)	Humidity	Light and Radiation	Wind	Lattitude and Altitude
Sprouting	Optimum 26-33oC Minimum 18 oC	Optimum 23-28oC Minimum 19 oC	initiated by water		Can sprout in the dark also		
Tillering	Assisted by cool nights	less if soil is warm	helped by sufficient miosture in the soil		depended on light		High tillering in high altitudes
Growth	Optimum at 30-33 Poor <20 oC	Optimum at 23-29 Poor <21 oC	Adequate moisture essential	Better in Humid air	Radiation controls Growth	hindered by wind	varies according to season at high altitudes
Flowering	Warm nights helps Halted by few nights at 18 oC	maximum in warm soils	optimum in moist soils, halted by drought	Some humidiy is required	slowly decreasing daylength prompts		Interacts with temperature
Ripening	prompted by cold nights, Optimum <15 oC	best at low temperatures	prompted by lack of moisture	better in very dry climate		better in windy conditions	Optimumat 1000m and 0 o Lattitude 500m at 15-20 o L 0m at 20-30 oL
Over Ripening	prompted by return of hot season	helped by increase in temperature	prompted by water being available after a dry period		slow in strong light	frequent with strong winds	reduced at higher lattitudes or altitudes

those have developed during the previous crop. A friable seedbed without clods are necessary for maintaining the effectiveness of drip irrigation as the capillary rich soil profile (adequate porosity) will allow for spread of moisture laterally and vertically from the point source.


Organic manure applied in the furrows

One deep ploughing and two cross harrowings are recommended. If the field has large clods or old cane stumps, Rotovator helps in clod crushing, making soil loose and providing fine tilth. Furrows are formed at 75 to 90 cm according to the soil type and planting pattern. Organic manure like well decomposed FYM should be added in the furrows only to increase its efficiency.

Sugarcane Varieties - There are number of varieties available based on the suitability of different states of the country. For example, in Maharashtra CoC-671and Co-86032 and in the drier parts of TN Co-86032 are found to be the best varieties for high productivity and sugar recovery. List of varieties released for commercial cultivation in different states is given below :-

Utter Pradesh	: CoS-687, CoS-87216, Co Pant-84211, CoS-767, CoS-802, CoS- 7918, CoS-8315, CoS-8432
Bihar	: BO-90, BO-99, Co-87268, BO-104, CoS-767, BO-109, BO-106, BO-128.
West Bengal	: BO-90, CoJ-64, Co-7218, Co-997, Co-1148, Co-7224, Co-62175, Co-62023, BO-91.
Orissa	: Co-6907, Co-7508, Co-7704, Co-8014, Co-62175, Co-7219, Co-740, Co A-89085.
Assam	: Co-1008, Co BLN-9102, CoBLN-9130, Co-6907, Co-8315, Co-1132, Cajor-1 & 2
Punjab	: CoJ-64, CoJ-83, Co-Pant-84211, CoS-8436, Co-89003, CoJ-85, CoS-767, Co Pant-90223.
Haryana	: CoJ-58, Co-7717, CoJ-64, CoS-8436, CoS-767, COLK-8001, Co-975.
Rajasthan	: Co-997, Co-527, Co-6617, CoH-92201, Co-419, Co-527, CoS-91230, Co Pant-90223
Madhra Pradesh	: Co-527, CoC-671, Co-7314, Co-1169, Co-678, Co-419, Co-7318, Co-7807, Co-767

Gujarath	: Co-671, Co-85004, CoC-86008, Co-86032, Co-8021, Colk - 8001.
Maharashtra	: CoC-671, Co-86032, Co-8014, Co-85004,
Karnataka	: CpC-671, Co-91002, Co-86032, Co-8011, Co-87044.
Andhra Pradesh	: CoC-85038, CoA-7706, CoV-92103, CoA-8801, CoA-89082, Co-8504.
Tamilnadu	: CoC-95071, CoC-671, CoJn-86141, Co-86032, Co-86249, CoC-93076.
Kerala	: CoC-671, CoJn-86141, Co-785, Co-62175.

Seed Selection

Though yield of Sugarcane is depended upon variety, quality of good seed is an equally important criterion. Sugarcane is propagated by cuttings or sections of the stalks called sets. The set should be:

High quality sets

1. Fresh & Juicy
2. Age should be of 9 to 10 months .
3. Should be free from Pest & Disease
4. Eye buds should be fully developed.
5. Select set from planted cane for seed and never from a ratoon cane.

Seed Treatment

Seed treatment is necessary for prevention of fungal diseases. Sets should be dipped for 15 minutes in a solution of Bavistin 100 gm and Malathion 250 ml in 100 liters of water.

Seed Treatment

PLANTING METHODS AND SEED RATE

Ridge and Furrow method

Normally sugarcane is planted on ridges and furrows method by using three eyed (buded) sets. Furrows are opened at every 75-90 cm according to the soil type. For this method 3.5 to 4 MT seed is required per acre.

Instead of conventional method of planting, for maintaining optimum plant population and easy management and for higher production, row method of sugarcane planting is developed. This is the best method of planting, and in this

method furrows are opened in a field at 75-90 cm according to the soil type. In medium type soils furrows are opened at every 75 cm and in heavy soils furrows are opened at every 90 cm.

After opening furrows well decomposed FYM is spread in them. A basal dose of Phosphate & Potassium fertilizers, along with micronutrients and phorate granules are placed in the furrows and covered by top soil. Then planting is carried out.

Nowadays planting is done by two eyed sets keeping 4-6 cm distance between two sets. For this 2 to 2.5 MT seed is required per acre planting.

STP method with single eye set

Recently, in STP (Spaced Transplanting) method single eyed sets are used for planting. Either direct sets or seedlings raised in polybag nurseries are transplanted into the field after 50-55 days. For this STP or single eyed set method 750 kg - 1 MT seed per acre is required. This method saves seed cost by 60-70%. In this method distance between two sets kept at 30 cm.

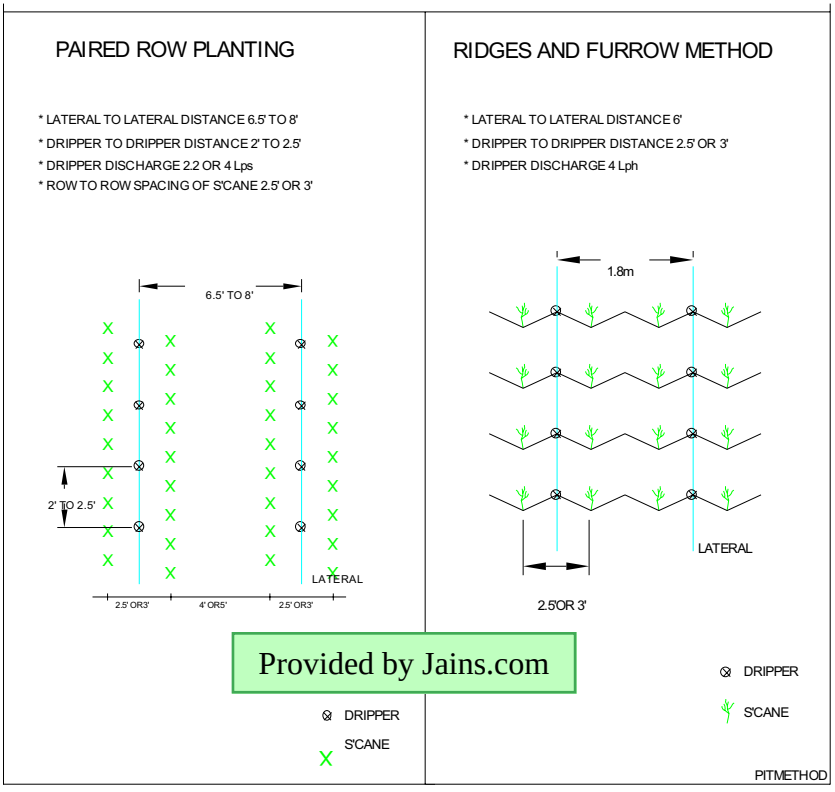
Paired row method

Paired row

In pair row method of planting cane sets are placed in subsequent two furrows and next furrow should be kept free of sets. In paired row method of planting row to row distance vary from 2.5' to 3' depending upon soil type. One Lateral (Inline tubing) is sufficient to irrigate both rows. Hence lateral to lateral distance varies from 7.5' to 9' and dripper to dripper spacing varies from 60 to 90 cm. The paired row method of planting is more popular among the farmers. The cost of drip system is reduced by 25-30%. There is a saving in seed cost. Growing intercrop in the space between the pairs, is possible. The crop management becomes easy, crop gets sufficient sunlight and hence grows faster. In this method cane produces more tillers and millable cane. Along with proper water and fertilizer management practices yield increases significantly.

Wide furrow method

Wide furrow method of planting is also a new method of planting. Planting of sugarcane is carried out in alternate furrows, leaving a row to row distance about 150 cm. Inline drip lateral is provided to each row of cane.



PROPAGATION OF CANE AND GERMINATION IRRIGATION

Each set contains one or more buds and a circle of small dots above the node which are the root primordia. While germinating the buds develop into primary shoots and the primordia develop into set roots. The set root initiation and extension requires continuous presence of moisture in the top soil.

An eye showing bud and root primordia

Germination of Set

During first month after germination the young plant lives at the expense of reserves present in the stalk piece (set). However adequate water should be made available in the soil. Therefore continuous application of drip irrigation for 8-12 hours per day for a week after planting or sprinkler irrigation till *incipient ponding* occurs.

Different growth stages and their duration

1.	Germination	15 to 30 days after planting
2.	Tillering	50 to 120 days
3.	Grand Growth Phase	121 to 210 days
4.	Maturity	210- 365 days

Roots and Water & Mineral absorption

The cane root system is special in the sense that the roots formed from the set dies off when the roots from the shoots start to develop. These adventitious roots from the shoot are the major functionaries. They carry out the functions of anchorage and absorption. Studies have shown that the upper 30 cm soil contains 40-60% of the total root weight. Another 20-30% is present in the 30-60 cm zone.

Root development is influenced by moisture, soil pore (aeration) and nutrients mainly P and Ca. After ensuring good germination the next important thing is to ensure a healthy root system development. An early dose P fertilizer is essential for this.

Tillering, the major yield component

The process of stool formation through successive production of shoots is tillering. Tillering is affected by light, temperature, water and nutrients and density of planting. The number of stalks (stem) per unit area is the most important yield component hence tillering is critical for high yields.

Tillering

Tillering in ratoon

IRRIGATION OF SUGARCANE

There is a misconception among sugarcane growers that the crop requires a large quantity of water and hence flood method of irrigation has been widely in practice. Estimates of water requirement of sugarcane records an average of 1500 mm (i.e. 150 lac l per ha for full season) to produce 100 t millable cane. Take note that this includes rainfall also. However in actual practice of flow or flood irrigation high quantum of water averaging over 2000 mm (200 lac l per ha) is applied by irrigation alone.

Soil moisture behaviour in flood irrigated field

Flood irrigated field

For the first two to three days after an irrigation there is excess water in soil water logging the crop. The cane suffers from lack of air in the soil and it reduces absorption of nutrients and water. From the 4th to 7 th day the soil maintains field capacity allowing the cane to restart its growth when the roots become active again absorbing air, water and nutrients. In the last 2-3 days water becomes deficient in the root zone and crop undergoes water stress. As the root zone is dry, the absorption of water, air and nutrients is inhibited. Therefore in the flood irrigated situation cane crop undergoes periodic cyclic stress for water, nutrients and air. The production of dry matter (which contributes to yield) also become cyclic. This affects yield formation. Application of water daily in small quantities as per the requirement of cane as practiced in drip method of irrigation obviates this cyclic nature of growth and dry matter formation occurs at a steady rate. Hence higher yields are recorded under drip system of irrigation

In the flood method of irrigation 70-75 % water goes waste due to leaching, and evaporation losses. The irrigation efficiency of flood method is only 25 to 30 % . Additionally, the use of excess water and imbalance dose of fertilizers degrades the soil making it saline, and/or alkaline, resulting in decreasing cane productivity.

The irrigation efficiency of drip method is 90-95%. There is very little wastage of water. Soils are in fact, reclaimed by using controlled irrigation and use of acid based fertilizers with drip irrigation.

Advantages of drip irrigation in Sugarcane

1. Saving of irrigation water (40-70%)
2. Crop yield enhancement (60-100%)
3. Enhancement in sugar recovery (up to 1%)
4. Increased fertilizer use efficiency and saving of fertilizer up to 25%.
5. Saving of electric power in pumping.
6. Improved pest and disease control.
7. Lowering of labour costs for irrigation
8. Decreased weed growth and hence saving in labour cost
9. Suitable for any type of terrain or soil
10. Maintains soil health and prevents soil degradation
11. Ideal for marginal lands and inferior quality irrigation water

Drip System for Sugarcane

Jain Inline drip system where drippers are placed inside the lateral tubes (*J-Turboline*) is best for sugarcane crop which gives uniform discharge and continuous wetting pattern.

J-Turboline showing the inline drippers

- J-turboline is a flexible and seamless tube with drippers permanently placed inside.
- It has a large cross-sectional turbulent flow path that makes it a clog resistant emitting pipe.
- Additionally, the dripper has two inlet filters that avoid the possibility of any blockage.
- J-turboline has three orifices at every dripper to ensure efficient performance for longer time.
- J-turboline is easy to roll back and re-lay a feature especially suitable for sugarcane cultivation and ratooning.
- J-turboline is supplied at various dripper-spacings to suit the varied soil conditions where cane is grown.

Installation of Drip System:

In the conventional 3' rows J-turboline is placed in every alternate row, at a spacing of 6' between the laterals.

In paired row planting method one lateral is paced between two adjacent rows of cane, i.e. lateral spacing at 7.5'. Spacing of drippers varies from 40 to 90 cm depending on soil type, which gives continuous wetting pattern reaching both rows of cane.

In wide furrow method planting is done every 4.5' to 5' and independent lateral is provided to every plant row. Hence distance between two laterals is 4.5' to 5' and dripper placement at 40 cm to 90 cm according to soil type.

After installation of the system, operate the drip system 12-24 hours for to bring soil moisture at field capacity level. Planting should be done very carefully at 6 cm deep and all sets should be covered by soil.

For germination irrigation raingun sprinklers can also be used. After planting 2 light irrigation should be given by raingun sprinklers followed by drip irrigation. This will result in maximum plant stand with no gaps and optimum plant population is achieved.

Water requirement of Sugarcane through drip irrigation

Planting Season - Jan / Feb. l/meter length of lateral.

Month	Distance between lateral to lateral (m)		
	1.5 (Conventional)	1.8 (Wide furrow method)	2.7 (Paired Row)
Jan (Planting)	4	4.5	5
Feb	6	7	8
March	8	9	10
April	10	11.5	13
May	12	13	15
June	8	9	10
July	6	7	8
Aug	6.5	8	9
Sept.	9	10.5	12
Oct.	10	12.0	13
Nov.	11	13	15
Dec.	10	12	15

Planting Season Oct - Nov

	Month Distance between lateral to lateral (m)		
	1.5	**1.8**	**2.7**
Oct.	4	5	5
Nov.	5	6	8
Dec.	5	6	7
Jan.	8	8	10
Feb.	8	10	12
March	10	12	16
April	12	14	20
May	14	16	22
June	12	14	16
July	10	12	14
Aug	10	12	14
Sept.	12	14	16

MINERAL NUTRITION OF SUGARCANE

For the correct nutrition schedule of sugarcane, knowledge of its growth physiology is essential.

There is an initial phase of slow growth of about 6-7 months followed by a fast rate which lasts for another 6-7 months. In the second phase about 75% of dry matter is accumulated. Therefore the nutrient supply should take care of this important issue. Interestingly, in the conventional cultivation practices last split of fertilizer is given before the completion of first six months leaving the rapid growth phase to depend on soil reserves and stored nutrients in the plant. The difficulty in actually placing fertilizer in the row while banding the fertilizer in tall and close crop is one factor forcing the cultivator to complete the fertilizer application before 6 months.

In the context of drip irrigation this difficulty does not arise and fertilizer application can continue up to 8 months. However a very late application of N-fertilizer is reported to have deleterious effect on sucrose accumulation which will affect the producers economically. Late application of N alone will increase succulence and the content of reducing sugars both are factors responsible for reduction in recovery. However if K is also given in adequate measures, the effect of excess N on recovery will be compensated. In fact K nutrition at late stages and its relationship to moisture often decides yield and improves recovery.

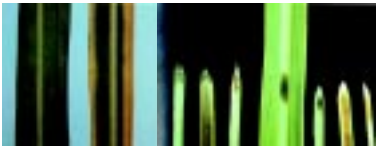
Field diagnosis of nutrient deficiencies

Nitrogen deficiency is easily diagnosed in the field. The plants show yellow green leaves and growth retards. The stems (stalks) become thin and the older leaves dry up prematurely.

P-Deficiency

Phosphorus deficiency reduces the length and diameter of stems and they taper at the growing point. The number of cane per stool reduces and inter nodes become smaller. Leaves become narrow and short with their tips showing drying up.

Potassium deficient plants exhibits yellowing and spotting of the older leaves. The older leaves turn orange and later brown. The leaves will start die-back from the margin and tips.



K-Deficiency

Under **Ca** deficiency young leaves become cholorotic and at extreme deficiency the rind becomes soft. Ca is not generally applied except for problem soils.

Mg deficiency results in chlorosis as the element is an essential component of Chlorophyll. The symptoms appear on the older leaves and later change into brown and gives a rusty appearance. The stems become shorter. Foliar spray of MgO is recommended.

When **Iron** is deficient, the normal green colour disappears between the vasular bundles (veins) and such pale strips extends the entire length of the leaf blade. The symptom first appears on the young spindle leaves and then extends to the older leaves. Fe deficiency is prevalent in high clay soils and lateritic soils of low pH. Foliar spray of Iron sulphate corrects the deficiency.

Fe-Deficiency

Mn deficiency symptoms are pale-yellowish, green, longitudinal stripes which alternate with normal green colour. The symptoms first appear on older leaves.

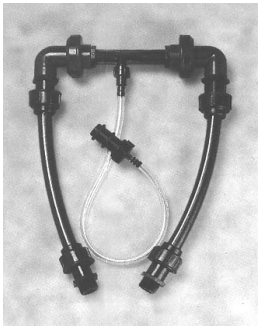
Zn deficiency causes light yellow streaks between the veins of the leaf blade. Zn shortage results in drastic yield reduction. Application of up to 5kg/ha of Zinc oxide or Zinc sulphate along with the regular fertilizers remedies the situation.

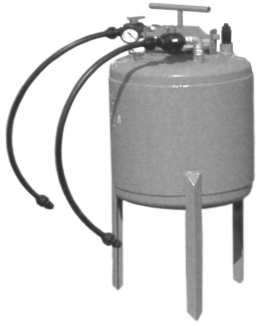
Mn-Deficiency

Boron though required in very low concentrations is essential for cell division. Deficiency of B results in ladder like lesions on the leaves. The leaves curl.

Cu-Deficiency

FERTIGATION





Fertilizer Injection Systems - a) Ventury b) Fertilizer Tank c) Fertigation Pump

Absorption of nutrients by the cane plant depends on the availability of soil moisture. In drip irrigated cane fertilizers when applied through the irrigation system (fertigation) meets this criterion very efficiently. The very dilute solutions of fertilizer, applied through the drip system, is the most effective way of fertilizer application.

In conventional method of application fertilizers are either banded near the crop row or broadcast in the inter -row space. Water is then allowed to flow through the inter- row space. Major share of the fertilizer is washed away to the end of the field or to the side drains. The localization of nutrients at the root zone is very poor in the latter method. Hence fertilizer use efficiency by plants is also very low.

Fertilizers such as Urea or Ammonium Sulphate needs to be placed at a certain depth in the soil to be effective. Here again the conventional application method is faulty where a large dose of solid fertilizer is placed on the surface and flow irrigated. In fertigation the nutrients applied at very low concentrations through water will move down into the lower soil layers containing the absorptive roots.

In integrated nutrient management total fertilizer dose is with use of inorganic fertilizers like Urea, Ammo sulphate, SSP, DAP, MOP or water soluble fertilizers, organic manures like well digested fym, compost, neem cake, castor cake and Bio-fertilizers like Azotobactor, P-SB, K-SB.

Sugarcane removes 1.2 : 0.46 : 1.44 Kg of NPK per ton yield and therefore the fertilizer requirement 1kg N/t for plant cane and 1.25 to 1.5kg N/t cane for ratoon. For an 80 t/acre yield the fertilizer recommendation would be 100: 40: 115.

Steps for effective fertigation

1. Installation of drip irrigation should be as per an accurate design.
2. Wash the filter element before starting fertigation.
3. Flush the laterals daily.
4. Fertigation should be done towards the end of an irrigation event. This is to ensure that the fertilizer is washed away from the root zone by the incoming water flow.
5. After the completion of fertigation, irrigation should be continued for another 15 minutes. This will ensure the total removal of the fertilizer from the irrigation system.
6. Concentration of fertilizers in effective root zone should not exceed 1000 ppm.

Fertigation Schedule, an Example

	N	P	K
Dose Suggested (Kg./Acre.)	100	45	45

(Add well decomposed FYM - 10-15 t/acre in furrows)

Fertigation Schedule - Liquid Fertilizer

Duration in days	Grade	Quantity Kg/Acre	Application Kg/day/Acre
After germination 15 to 60	19:19:19 + Urea	50	1.111 + 1.688
61 to 170	19 :19:19	68	0.618 +
	12:61:0	36	0.327 +
	Urea	75	0.681
171 to 250	13:0:46	55	0.687

Note : Above schedule is only for information. It may change according to soil nutrient status and crop growth rate experienced in the area.

Use of Conventional Fertilizers through fertigation

N P K

Fertilizer dose **100 : 45 : 45 Kg/ acre**

Duration	Grade Kg/ha	Quantity Kg/day/Acre	Application through drip
At Planting	SSP	360	Soil application in furrows
After germination up to 4 months (12 weeks)	Urea MOP	323 96	27.00 + 8.00
At earthing Up	SSP	360	Before earthing up in furrows.
5th to 7th Months 12 weeks	Urea MOP	216 96	18.00 + 8.00

Note : Above schedule I for your guidelines only, change can be made according to soil analysis, crop growth stage own experience.

Through Soil Application.

Application Time	Urea	SSP	MOP
At planting	53.8	360	95.80
After 6.8 weeks	216	-	-
After 12-16 weeks	53.8	-	-
At Earthing up	216	360	95.80
Total	539	720	191.60

Micronutrients : In addition to nitrogen, phosphorus and potash, other nutrients viz magnesium, zinc, iron and boron are also required. These are applied to the soil at the following rates in two splits;

Zinc sulphate	-	10 Kg/Acre
Ferrows sulphate	-	10 Kg/Acre
Magnessium sulphate	-	50 kg/Acre
Borax	-	2 Kg/Acre

First dose is added at planting, and remaining half dose should be applied at the time of earthing up.

INTER CULTURE

Keep sugarcane field free from weeds. Weeds compete with the crop for water and nutrients and reduce yields significantly. Weedicides available in the market -Stomp or Atrataf, or Cencer or Goal or Gramoxane can also be used.

Interculture also helps in proper aeration in the effective root zone. Hoeing is done for better aeration water penetrability and weed control.

EARTHING UP

Hilling the clumps in stages is required to provide habitat to the shoot roots and sufficient height of the soil thus achieved suppresses the formation of late shoots. The earthing-up changes the furrows into ridges and ridges into furrows which permit drainage of excess water during rains. Earthing up is done at maximum tillering stage.

Earthing up operation

In paired row method of planting, soil is loosened in blind furrow area and used to support sides of sugarcane rows. Raised bed is prepared and the irrigation lateral tube is placed on raised bed between the two rows of cane. Resultant height of 1.5' prevents lodging, aeration in root zone is maintained, and water movement is facilitated.

INTER CROP

For getting higher economic returns intercropping in sugarcane field is necessary. Onion, potato, cabbage, cauliflower, leaf vegetables, groundnut, soybean, etc. can be taken in initial stage of the cane crop. The intercrop species should not be a heavy feeder and should have shallow root system, and will be of 90-100 days duration.

Intercrop

RATOON MANAGEMENT

Ratooning of cane is very essential for increasing the benefit to the farmer. Ratooning saves expenses as land preparation, planting material cost, seed treatment cost, and planting expenses.

Poly-bag Seedlings for gap filling in ratoon

Proper management of ratoon crop is necessary. In India the potential of Ratoon crop is always under estimated hence yield of ratoon is low.

By good management of irrigation and nutrition it is possible to get better yields from ratoon crop. In Karnataka Mr. Prafulla Shah of Shimoga district is taking 39th ratoon crop with average yield 36-38 t / acre. Preferably cane harvested before February is generally advised for ratooning. While harvesting of the main crop, drip laterals should not be damaged.

After harvesting the trash is collected and spread in furrows. Then stubble shaving is completed. Then give water stress for eight days. The interfurrow spacing should receive one deep cultivation to improve the soil physical condition & also to prune the stubble roots. The ridges should be dismantled after the harvesting of the main crop. The fertilizer dose is applied as per the main crop. After application of fertilizer and dismantling of the ridges start irrigation by drip. Initially operate the system for 8-10 hours to bring soil at field capacity. For gap filling in ratoon crop polybag nursery should be raised with single eyed set and transplanting should be carried out in field after 45-50 days for maintaining optimum plant population.

FIELD MAINTENANCE OF DRIP IRRIGATION SYSTEM

Success of drip irrigation system mostly controlled by three factors,

a. Design of the system,

b. Quality of the material used and

c. Maintenance of the system.

First two factors, design of the system and quality of the material used are by and large controlled by the manufacturer, but maintenance of the system is controlled by the end user. System fails or does not perform well due to ill maintenance of the system. In India, most of our end user are layman farmer who either are not aware of system maintenance or do not care for the system maintenance.

Importance of Drip System maintenance :

There are basically two reasons why maintenance of drip irrigation system.

1) Water is not found in it's purest form in nature. Always it contains some physical, chemical & biological contamination which may block pipeline, laterals & drippers in the system.

2) The function of dripper / emitter is such that it has to convert flow of water from high pressure (nearly 1.0 Kg/cm^2) to atmospheric pressure when it comes out through emitter, so as to get discharge in the form of droplet. In doing so flow of water has to pass through labyrinth, turbulent & minute flow path. There is always a chance of blockage of this flow path due to dirt particles or due to chemical precipitation.

Emitter Clogging

In drip irrigation system water source can be an open well, borewell, pond, canal or river. Quality of water varies with its source. Emitter/Pipe line may clog due to following reasons,

1. Particulate Contamination
2. Expansion and Contraction (forcing dirt in emitter outlet)
3. Insects and Rat/Squirrel Nuisance
4. Algae and Bacterial Growth & Precipitation
5. Chemical Precipitation

1. Particulate Contamination

Particulate contamination occurs from the following:

A. Insufficient filtration; small particles of soil either bypasses the filter or go through the filter.

B. Particles introduced during installation and insufficient high flow flushing of drip lateral.

C. Particles introduced during mainline repair or with leaks in mainline, soil will wash back into the system when shut down.

D. Particles introduced during lateral disassembly and assembly.

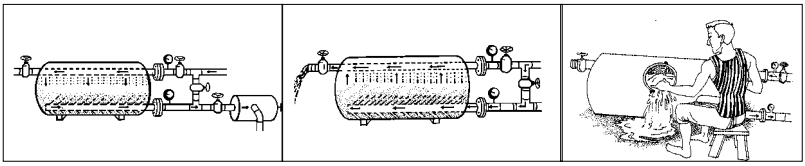
E. Particles introduced during replacement of emitters.

Filters have to be sized to the requirements of the emitter manufacturer. Different emitters have different filtration requirements. If the filtration size is too large, smaller particles that can cause plugging will pass through the filter.

If filters receive a high load of particles or are not flushed or cleaned often, sediment can bypass the screen (depending on the design of the filter). Regular backwash of the screen and media filters is highly essential for optimum filtration efficency. Frequency of backwash operation for screen and media filters depends on quality of water. The thumb rule is, if the differential pressure between inlet and outlet of the filter is beyond 0.5 kg/cm² then it is time for backwash. If contaminant load is very high and frequent backwash is the problem, semiautomatic or fully automatic screen/media filters are recommended.

In case of media filters, level of the sand should be maintained as recommended by the manufacturer. Check the media frequently, if the media is getting rounded off due to continuous abrasion, change the media.

Similarly in case of screen filter check the filter element and the gaskets closely. Polymer mesh screens can be damaged easily and will deteriorate over a period of time. Be careful of the chemicals introduced into the system. Some chemicals will cause premature failure of polymer screens. Look out for trace amounts of solvents, toluene, methylethylketons, or any of the higher volatile solvents that dissolve plastics. Check with the filter manufacturer for susceptibility to different chemicals. Quality of water also decides the filtration screen to be used e.g. if source water contains high concentration of sulfides, it may react with stainless steel to form iron sulfides which will precipitate in the system.



Sand Filter (Normal Mode) Sand Filter Backwash Mode Sand Filter (Cleaning)

Particles will be introduced into the system during assembly. It is almost impossible to prevent. The system has to be flushed before any lateral is connected to the system. A properly designed system will have flushing points built into the system at the end of all mains, submains and before all solenoid and isolation valves in the field. If, at any time the mainline or submain is broken into for repair, the system or parts of the system can be flushed. As high a flow as possible should be used to flush the mainlines and submains, Laterals should be flushed with as high a flow as possible. It may be necessary to isolate some of the laterals on a common submain to increase the pressure enough to create a high flow, especially on long length laterals with pressure compensation emitters.

One of the most common sources of contamination in a drip system occurs when a buried mainline or submain develops a leak. When the system is shut down at the end of an irrigation cycle, water and soil can wash back into the mainline and end up in the emitters. This can cause continual plugging or drop in flow on all emitters. It can cause excessive flow on self-flushing emitters in addition.

Another common source of contamination comes from repairing mainlines and submains. The system should always be flushed before operation after any repairs. If possible isolate all laterals connected down stream from the repair point to prevent contaminants from entering the laterals. If shutoff valves are not used on the laterals, the tubing can be clamped to isolate the lateral.

Emitters can be cleaned without pulling them out from the laterals. While pulling the emitter, the hole in the lateral may become oblong causing leakage.

When replacing emitters be sure to clean the bad emitter before removing it. If the tubing is dirty, some dirt will enter the tubing when the new emitter is inserted.

Another hidden reason to cause particles enter the system is improper position of the footvalve. If footvalve is very close to the bottom, it may suck dirt inside the system. Always keep distance between footvalve and the bottom of the well.

2. Expansion and contraction of tubing

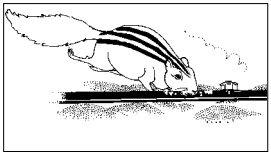
Expansion and contraction of the drip laterals can pull or push emitter openings into the dirt and plug the emitter outlets. This can happen when the system is shut down and the dirt is moist and when emitters are on the bottom of the tubing. Emitters are to be installed on the top of the tubing.

3. Insects and Rat / Squirrel nuisance

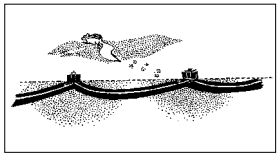
Insects such as ants and beetles can damage emitters and thin wall tubing. When moisture is scarce as when a drip system is shutdown, insects will chew into emitters and thin wall tubing to get at the water. Control of these pests with insecticide is important as they can render a system inoperable in a short period of time.

Other types of insects will build a cocoon inside emitter outlets and distribution tubing. Insecticide can be used to control these pests also. Cocoons are built when the system is shut down for a period of time. These pests need only be controlled during this period.

Another major problem is of rat or squirrels, they damage the system by chewing holes in the lateral lines. Use of subsurface laterals is one of the way to get rid of this problem. If the laterals are layed on the ground always keep a continious wetting strip. Rat generally never cross the wet surface. Some rat repellent chemicals are also available in the market but it must be checked that it should not be harmful to the plant.



Squirrel Menace
Lateral on the Ground Surface



Lateral below the Ground at
a depth of 3" - 4"

4. Algae and bacterial growth & precipitation :

Growth of Algae

One of the most important problem in the maintenance of the drip system is growth of algae, either in the water source or inside the system.

Algae can cause great nuisance in the surface water because, when the conditions are favourable they will grow rapidly reproduce and cover entire surface of the source in the form of large floating colonies called blooms. It may cause difficulty with screen or media filtration systems, by clogging the screen or media surface.

Prevention

Algae can be effectively controlled in surface water by adding copper sulphate from 0.05 to 2.0 ppm. The amount of chemical required may be based upon treatment up to 6 feet of water surface. Since algae growth may occur in upper surface of water where sunlight is intense. Copper sulphate can be placed in a bag anchored with a float at various points or can drag on surface after putting it in cotton sacks.

Bacterial growth and precipitation

Certain forms of bacteria produce a slime growth on the insides of tubing and emitters. If the system is shut down for a length of time, the bacterial slime dries. When the system is operated again the dried slime can break apart and plug emitters.

Another form of bacteria precipitates iron out of solution in the water and form long stringers of iron rust-red sludge which can also plug emitters.

Bacterial growth with a sulfur precipitate is another type of bacterial growth that will form a white cottony slime if more than 0.1 ppm of sulfides (not sulfates) are present in the water. If the water has a smell of rotten eggs usually hydrogen sulfide is present in the water and bacterial sulfur slime will occur.

Prevention

Bacterial growth can be controlled by using chlorination of the water supply. Chlorine when dissolved in water acts as a powerful oxidising agent and vigoriously attack microorganisms such as algae, fungi and bacteria.

Common chlorine sources

* Calcium Hypochlorite (Bleaching Powder) - contains 65 % freely availaible chlorine (HOCL & OCL^-)

* Sodium Hypochlorite - Liquid form with 15% freely availbale chlorine.

* Chlorine gas

Recommended Chlorination:

Continuous - 1 ppm free chlorine, (2-3 ppm may be required at the pump to get 1 PPM at the end of the drip lateral.)

Intermittent - 10-20 ppm for 30-45 minutes frequency depends on the level of contamination but generally once in a fortnight.

Superchlorination - Shock treatments with concentrations of 'free' chlorine as high as 50-500 ppm are sometimes used to clear a system of algae and bacterial growth if has a high amount of growth. When chlorine shocking a system, the chlorine should be let to sit in the laterals for a period of time, such as overnight.

Calculation of Injection Rate :

Sodium Hypochlorite

IR = (0.36 x Q x C) / S

Where, IR -Inj. Rate lph,
Q - System Flow lps,
C - Desired Concentration ppm,
S - Percentage of free available chlorine,

Calcium Hypochlorite -

IR = (360 x Q x C) / W x S

Where,
IR - Inj. Rate lph
Q - System Flow lps,
C - Desired Conc. ppm.
S - % of free available chlorine,
W - Concentration of solution gms of $Ca(OCL)^2$/ltr.

Gaseous Chlorine

Chlorinator can be used to inject gaseous chlorine in to the system.

Injection Rate =3.6 x Q x C

Where,
IR = Injection Rate in gms/hr
Q = System Flow in lps.
C = Desired concentration in ppm.

Examples :

A. Chlorination using sodium hypochlorite

A farmer wishes to achive 15 ppm chlorine concentration at the injection point of the system of flow 7 lps using 10 % sodium hypochlorite (liquid form)

Injection Rate (IR) = (0.36 x 7 x 15)/ 10
= 3.78 lph

B. Chlorination using Calcium hypochlorite

A farmer wishes to achive 20 ppm chlorine concentration at the injection point of the system of flow 12 lps. A solution of calcium hypochlorite of 100 gms/lt. is made up (i.e. 5 kg. of calcium hypochlorite in 50 lt. of water)

Injection Rate (IR) = (360 x 12 x 20) / (100 x 65)
= 13.3 lph

5. Chemical Precipitation

Calcium / Magnesium Carbonates:

Calcium / Magnesium carbonate precipitates form a white coating on the outlet of emitters. The build-up of these salts can eventually close off the emitter.

Calcium and magnesium carbonates can form when the concentration is greater than 50 ppm and the pH is over 7.5.

Sulfides:

Sulfides in the presence of iron from iron sulfide. Stainless steel (or any steel) filter screens will plug by the formation of iron sulfides on them. Only plastic filter elements should be used if sulfides are present.

The use of fertilizers with iron in them will form a precipitate of iron sulfide in the system if the sulfide concentration is high enough. The precipitate is identifiable by its yellow/orange color.

Iron:

Iron precipitate can form if the iron content is greater than 0.1 ppm. The precipitate is in the form of a rust-red ferric oxide.

When unchelated phosphates or calcium salts are injected with fertilizers into systems additional iron precipitation can occur, especially if the iron content is close to 0.1 ppm or higher.

Prevention:

Iron precipitate is controlled by one or more of three methods:

1. Aeration and settling.
2. Chlorine precipitation.
3. pH control.

1. Aeration and settling

Aeration and setting is the low cost and easiest to accomplish for large systems. Large amounts of air are introduced to the water to allow the oxygen in the air to oxidize the ferrous oxide to ferric oxide. The ferric oxide will precipitate and settle out of the water if the velocity of the water is held low enough and long enough. Usually an aeration pond and a settling pond are incorporated. Note that this process requires a two pump installation except on a gravity feed system.

2. Chlorine precipitation

Chlorine injected at a rate of 1 ppm free chlorine to each .7 ppm iron will force the oxidation of ferrous oxide to ferric oxide which will precipitate out of the water. If chlorine is being injected to control bacterial growth, then the chlorine for iron control would be in addition to that used for bacterial control.

Control of the location where the precipitate settles out of the water is important. Settling has to occur before the filter. This is accomplished by mixing the chlorine and water adequately, allowing settling and then filtering the water. If this is not done, then the iron will precipitate out in the mainline and laterals and can cause plugging. The recommended filter in this instance is the sand media filter. An 'In-line mixer' downstream of the chlorine injection points aids in achieving precipitation in a controlled location. A pressure tank or enlarged mainline section ahead of the filter will allow some settling before the water gets to the filter on smaller systems.

Note : Manganese present in the water reacts with chlorine and precipitate out also, but oxidation takes longer. This will usually occur in the system and can cause plugging of the emitter orifice. Self-flushing emitter will generally handle this precipitate unless the amount of manganese is large (greater than .5 ppm). The laterals should be flushed periodically.

3. **pH Control**

Iron is more soluble at lower (acidic) pH values. The pH may rise when water is pumped out of an aquifer and then iron will precipitate out. Acid may be injected to maintain iron in solution, or it may be used periodically to dissolve iron sediments which are built up over the period.

pH is also used to control calcium and magnesium build-up on emitter outlets. This control method is usable unless the emitter is totally plugged, in which case the emitter has to be cleaned by hand or replaced.

Acid Treatment :

The injection of acid into drip irrigation system is primarily carried out to :

1. Lower the pH of the irrigation water and
2. Prevent the precipitation of salts.

Precipitation of salts such as calcium carbonate, magnesium carbonate or ferric (iron) oxide can cause either partial or complete blockage of the Drip Systems. Acid may also be used to lower the pH of the water in conjunction with the use of chlorine injection to improve the effectiveness of the chlorine as a biocide. Acid may also be effective in cleaning systems which are already partially blocked with precipitates of salts.

The most reliable step for deciding on acid treatment is a water analysis. Soil and water samples are collected during the survey and then analysed to recommend acid or chlorine treatments as per the water quality. Ventury, Fertilizer pump or Fertilizer Tank is used for chemigation & fertigation.

Injection Equippment

Injection Rate Calulation

$Qa = (3.6 \times Qs \times A) / V$

Where,

Qa - Inj. Rate of acid lph,

Qs - System Flow Rate lps,

A - Acid quantity in ml to achive the required pH in a water test sample of volume 'V' litres,

V - Volume of test sample litres.

Procedure for Acid Treatment :

1. Calculate the amount of acid to inject, For which the data required is,
   - Volume of water to be treated,
   - pH of Irrigation water,
   - Desired pH
2. Injection should be started with system operation.
3. Check at nearest emitting point the desired pH is achived or not.
4. Adjust the injection rate.
5. Repeat Step 3 and Step 4 until the desired concentration is obtained.
6. After injecting acid for 30 to 60 min. Stop injecting and shut the system fo 24 hr.
7. Flush all submains and laterals.

Precautions :

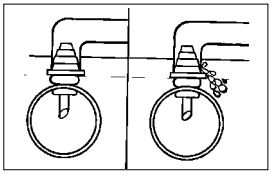
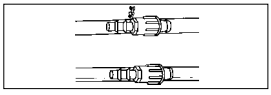
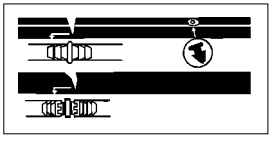
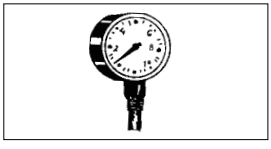
A) Acids are dangerous, they must be handled with care.
B) NEVER add water to acid, always add acid to water.
C) Ensure that equipment used to handle the acid is resistant to acid attack.

RECOGNITION AND RECTIFICATION OF CHEMICAL & BIOLOGICAL CONTAMINATIONS

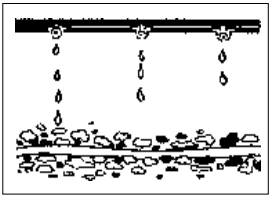
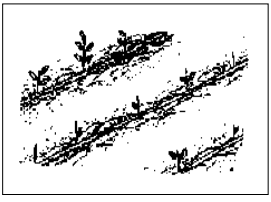
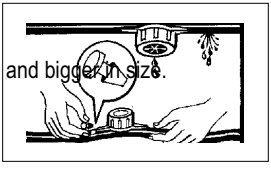
Sr. No.	Problem	Reasons & identification	Control
1.	Precipitation of calcium and Magnesium salts	Appears as white film on the inside of the lateral the inside of the lateral/drip tape or in the flow path of drippers associated with increase in pH or decrease in temperature of water.	Continuous injection of acid to maintain pH of 6.0 - 6.5 sufficient to prevent formation of precipitation
2.	Precipitation of Calcium Carbonate	While in solution there will be no problem. But as soon as system stops and water evaporates calcium precipitates as white crystals around dripper/drip tape orifice and blocks the holes.	Continuous injection of acid to reduce pH of water upto 4.0 Repeated treatment for severe blockages.
3.	Precipitation of iron	Changes in temperature and pH cause iron to oxidise to insoluble ferric form causing precipitation.Precipitation forms a red slime mass.	Acid treatment to lower the pH upto or less than 4 and then thorough flushing after 24 hours.
4.	Precipitation of Manganese	Manganese can precipitate out as manganese oxide either by chemical or bacterial action and colour of deposit is dark brown or black.	Acid or intermittent Chlorine treatment.
5.	Growth of algae within water supply	These need light to grow and hence are found in all surface storage ponds, wells and in slow moving water. Grow quickly and profusely to pose severe problems.	Effective control by adding copper sulphate to water depending upon its concentration which varies from 0.05 to 2 mg/ litre.
6.	Growth of algae within the system	There are chances of algae growth within filters, on ground mains, submains lateral, drip tape & drippers.	Intermittent Chlorine injection
7.	Bacterial precipitation of Sulphur/Sulphides	Bacteria can produce sulphur if water contains more than 0.1 mg/litre of total sulphides. These bacteria produce White cottony mass and completely block the emitting device.	Intermittent injection of chlorine
8.	Bacterial precipitation of iron	With changes in temperature and pH some bacteria cause oxidation of iron to insoluble ferric form causing precipitation. It forms red colour slime and some what gritty slush.	Intermittent injection of chlorine.

Note:-Copper sulphate is very toxic to human beings and animals and hence due precaution should be taken to avoid drinking this water.

TROUBLE SHOOTING AND REMEDIES

Sr. No.	Problem	Cause	Remedy
01.	Leakages at Submain 	• Lateral/polytube at the start is without sufficient allowance. • Quite tightly placed polytube with slight pull by animals or people. • Grommet takeoff comes out or gets loosened.	Dig the soil near submain and place correctly the grommet takeoff inside the submain. Keep necessary allowance for lateral at the beginning.
02.	Leakages at drip tape/lateral joints 	Like above due to slight jerks, joints get stretched and become loose.	Place correctly the nut of joiners and the joiners into drip tape at one end and lateral at another end.
03.	Leakages along lateral/drip tape 	Lateral/Drip tape is damaged by mechanical devices or by squirrels, rats, animals etc.	• Small holes in the lateral can be closed by goof plugs • At the cut section, put drip tape joiners correctly for lateral/ Drip tape or put required piece of it with joiners.
04.	Difference between the inlet & outlet of filter is more than normal. 	• Filters are not cleaned. • Quantity of sand is more in the sand filter. • Pressure gauge may be faulty	• Daily backwash the sand filter for atleast 5 minutes. • Clean sand & screen filters thoroughly by opening their lids atleast once in a week. • Change the faulty gauge • Allow dirty water to bypass first and then take into filter.
05.	Pressure gauge doesn't show readings 	• It has either gone out of work due to rusting or some jerk injuries or pointer has stuck up. • Presure beyond the operating range.	• To avoid rusting, position the pressure gauge such that rain water won't go in. • Put Plastic cover over it. If indicator is stucked up, open the gauge and check up the indicator. • Keep the pressure within the the operating range.

TROUBLE SHOOTING AND REMEDIES

Sr. No.	Problem	Cause	Remedy
06.	Non-uniform dripper discharge. 	• Clogged drippers. • Algae and salt accumulation inside drippers and laterals. • Submains and laterals are not flushed properly. Laterals are pinched or leakages developed somewhere along the length of lateral.	• Open the drippers and clean thoroughly. • Filters, Laterals and Submains are to be flushed regularly once in a week. • Carry out necessary chemical treatment as per the recommendations. • Check the lateral for pinching and leakages if any.
07.	Non uniform discharge with dry patches of soil in the drip tape system. 	• Algae growth within the filter or drip tape. • Salt accumulation inside tape & holes are blocked. • Air release valve is not at proper place or not working and hence silt particles are sucked in. • Clogging the holes due to negative suction created when irrigation is stopped.	• Daily backwash of sand filter for 5 minutes and flushing of submains and drip tape thoroughly once in a week. • Carry out acid and chlorine treatment as per recommendations • Air release valve should be located at the higher points along the submain.
08.	Leakages at dripper placement on the lateral.  and bigger in size.	• Drippers are taken in and out many times unnecessarily. • Holes become oblong	• Such holes can be closed with goof plugs. • For bigger holes put joiners.
09.	Low discharge with Low pressure reading	• Sand filters quite dirty and no proper cleaning • Water level in source has gone down. changed to further down. • Pump working is not proper.	Sand filter should be thoroughly cleaned and backwashed daily. • If water level has gone down, pump placemenshould be • Pump should be checked for its working. • If this doesn't then suggest new pump as per requirement of head and discharge.

TROUBLE SHOOTING AND REMEDIES

Sr. No.	Problem	Cause	Remedy
10.	No discharge at the lateral/drip tape end.	Lateral/drip tape is cut or pinched somewhere in between.	• Check lateral/drip tape along the length for pinching or cut. • Straighten it if pinched and put joiners wherever necessary.
11.	Excess pressure at the filters.	No by pass assembly.	Install bypass assembly to divert excess flow and maintain desired flow and pressure.
12.	Ventury is not working.	• Lower pressure than recommended at the pressure gauges. • Leakages in the ventury assembly. • Pump working is not proper.	• Control the By -pass Valve • Check pump Working for low pressure and check the ventury assembly properly fitted for its correct direction & leakages.
13.	Sand comes in the screen filter along with trash, straws etc.	Sand filter elements (black candles) are either loosened or not in the place.	• Check the black candles for their proper place and properly fitting. • While cleaning the sand filter, black candles should not be disturbed with hand movement.
14.	Very dirty water comes out at the ends of lateral/drip tape.	• Water is quite dirty with lot of silt. • Laterals/drip tapes are not flushed for a long time. tape holes get clogged.	• Lateral/drip tape should be flushed once in a week regularly otherwise drippers will give uneven discharge and drip
15.	Fibrous slime or white crustation growth material comes out through the lateral/ driptape ends.	• Water contains high quantity of salts in the form of white crustation • Laterals/drip tapes have not flushed for a long time.	• For salts in the form of white crustation, carry out acid treatment and for fibrous slime growth of algae carry out chlorine treatment as per the recommendations.
16.	Air release cum vacuum release valve leaking constantly.	Valve 'O' ring has deviated from its base and obstructs in the proper working.	• Position the 'O' ring properly or replace new if turn out.

FREQUENTLY ASKED QUESTIONS (FAQS)

1. ***Whether the meagre quantity of water given through the drip system is enough to satisfy the traditionally flooded sugarcane crop?***

   Amount of water applied through drip is not meagre. The quantity of water applied is pre-estimated based on crop, age, soil and climate. Farmers are provided with the irrigation schedule for the crop for its entire duration.

   Traditional flooding create excess water in the soil around the plant in the first 2-3 days of irrigation. It also creates a water stress in the soil in the last 2-4 days of the irrigation cycle. In drip irrigated fields the soil water is maintained at uniform level throughout. Sugarcane plant can absorb (including the general evaporation only 4-5 mm water per day). This is provided by the dripper.

2. ***The drip lines, laterals are an inconvenience during earthing up.***

   In a paired row planting there is enough space for cutting of soil by spade without the lateral coming in the way. In single row system the lateral in alternate furrows will not obstruct the earthing up activity if soil is cut from one side of the row. In fact farmers have been practising earthing up in drip irrigated cane crop for more than a decade now.

3. ***What will happen to the drip line while cutting the cane.***

   We recommend the farmer to pull the drip line at the submain end and roll it and place it at the end of the field. If the lateral gets cut, a very seldom occurrence, joiners are available to reconnect the cut ends.

4. ***The drip line is placed some distance away from the plant row. Whether water will reach the plant roots?***

   The water emitted from the drippers will move laterally and vertically. The rate of these movements are depended on the soil type. Your system is designed to provide a suitable wetting pattern for the crop and suiting to your field soil. Sugarcane roots reach up to 60 cm below in the soil. But most of the roots (60%) are in the top 40 cm soil. The discharge and running time is prescribed to see that the wetting circle covers this soil depth. The coalescing of wetting circles of each dripper will provide a continuous strip of wetness in the soil which is adequate for the row of cane.

Roots of plants spread towards the points of water availability which also ensures that the plants get adequate water in drip irrigated situations.

5. ***Can we use our existing pump for the drip system?***

   Yes. The company engineer will design the system taking into consideration of the existing pump.

6. ***Can we follow the existing planting style (pattern)?***

   Yes you can. But for cost reduction and higher yield of cane you may follow the paired row planting as described by our Agronomists.

7. ***But the plant population will be low in paired row?***

   Yes to a small extent. But because of higher lateral light penetration into the row cane will tiller more and the yield will be higher than what you get in row planting.

8. ***The dripper may get clogged or blocked?***

   The system requires periodical flushing with acid or chlorine. Based on the quality of the water the Company engineer will work out a schedule for cleaning and will demonstrate the cleaning procedure. The company also trains the operator on regular maintenance procedure, filter cleaning etc.

9. ***Whether the salt content in the water increase while adding fertilizer in irrigation water?***

   Addition of fertilizer in the irrigation water is of very low quantity, hardly raising the solute load to 10-20 ppm. First sugarcane is a salt tolerant crop and secondly a solute load of up to 1000 ppm is tolerated by Sugarcane.

10. ***Do the drippers block or clogg when fertilizer is applied through them?***

    Drippers do not block by fertilizer. First the concentrations of fertilizer in water is very low. Secondly most of the fertilizers in solution is acidic and therefore they will only assist in clearing any previous salt accumulation in the lateral or dripper.

11. ***Do we have to replace the drip lines every year?***

    No. The drip lines will stay in working condition for a minimum of seven years. The rest of the parts of the system will stay for 10-15 years. The buried PVC pipes will last a life- time. So drip line can be used year after year with proper

maintenance.

12. Do cane lodge because of drip irrigation?

No. Lodging occurs due high wind speed. It also occurs due to lower depth of sowing. Drip irrigated cane also extends its anchor root to similar depths as flow irrigated canes.

13. How many rattoons can be taken under drip irrigation?

Drip irrigation helps you to have more rattoons than what you are practising under flow irrigation. In other countries farmers go for 10-12 rattoons per crop under drip system.

14. Can I use the same drip system for other crops?

Yes. The system is suitable for other row crops, like vegetables, pulses, or cereals.

15. Can an intercrop be taken in cane?

Yes . Under drip system and Paired row planting one can successfully take an intercrop of vegetables, pulses or flowers.

16. What about rat problem? They will chew the laterals.

Rodents are common in sugarcane fields. They chew laterals for sucking water. Providing perches in the field for predatory birds, applying neem cake for the crop, keeping alternate water sources for rats outside the field etc. will reduce the menace. In situations where rats cut the laterals they need to be reconnected.

JAINS' OFFER TO SUGARCANE FARMERS

Jain irrigation in association with Sugar factories takes up turnkey projects for large scale adoption of adoption of drip irrigation technology in sugarcane culture. The company provides the following services besides supplying, installing and servicing the irrigation system.

1. Material Supply

Jain irrigation will establish a temporary stock point at the sugar mill or a nearby place where all components of the system are stocked. Supply of the system parts and later on spares will be made available from the local stock. This arrangement will make it convenient for the users.

2. Engineering Services

Jains' engineers will take up survey of each farm, and design, installation and commissioning of each system. The technicians stationed at the project site will train farmers in operating the system and on regular maintenance practices. They will take up periodical services also. At frequent intervals demonstrations of operations like fertigation, system treatment, flushing etc. will be conducted for farmer groups on site by teams of company experts.

3. Agronomic Services

Agronomic practices required for system adoption and for achieving high yield of cane will be explained to the farmers and to the cane officers for in extension classes conducted by company agronomists. Training programs are also conducted for farmer groups at the central training facility of the company located at Jalgaon. Booklets and pamphlets describing packages and practices will be given to the farmers.

4. Analytical Services

Soil and water analytical data from each farm are critical inputs in system design and prepaing the maintenance schedule. The company has modern analytical facilities and will take up soil and water analysis as per need.

5. Training and visits

Jain irrigation will train the farmers and system operators for system operation, maintenance and specialised activities like fertigation. The company will conduct classes and organise field level hands-on training programs. If required the company will train factory extension personnel also. The specialists from the company will visit the farms periodically offering suggestions.

ECONOMICS OF SUGARCANE CULTIVATION WITH DRIP IRRIGATION SYSTEM

	Farmer- K.K.R. Tamilarasu, Chokkanathapuram, Sivagangai, TN ** (2001-2002)			
1	**Area, acres**		1	
2	Row to Row Spacing, ft		2.5	
3	Spacing between pairs of Rows, ft		5	
4	Drip type: Turboline with integral drippers spaced at 0.75 m			
S.No	**Particulars**		**Spacing:**	
			Drip	**Flood**
1	**Fixed Cost**		25000	0
	a. Life (years)		10	10
	b. Depreciation, Rs (10% of [1])	10%	2500	0
	c. Interest rate, Rs (15% of [1])	15%	3750	0
	d. Repair & Maintenance, Rs (2% of [1])	2%	500	0
	e. Total (1b+1c+1d)		**6750**	**0**
	f. Fixed cost per acre, Rs =(1e/Area)		**6750**	**0**
2	Cost of Cultivation per acre,		20000	24000
3	Total Cost of Cultivation, Rs = (2)*Area		20000	24000
4	**Seasonal Total Cost (1e+3), Rs**		**26750**	**24000**
5	**Water Consumption,mm**		**1200**	**2000**
6	Yield of Produce, MT/acre		59	36
7	Total Yield of Produce, MT (6)*Area		59	36
8	Selling Price,Rs./Ton		780	780
9	Gross Income from produce,Rs = (7x8)		46020	28080
10	Net Seasonal Income,Rs = (9-4)		19270	4080
11	Gross Cost of Production,Rs		26750	24000
12	Total Gross Income,Rs		46020	28080
13	**Gross Benefit Cost Ratio = (12/11)**		**1.72**	**1.17**
14	Net Extra Income Due To Drip Over		**15190**	0
15	**Pay-Back Period, Years =(1/14)**		**1.65**	
16	**Water Use Efficiency, kg/ha mm.**		**121.44**	**44.46**

** *The Mill reports a recovery % of 12.16 under drip and only 11.81 under conventional Irrigation*

	Farmer- Sri Sanjeev Mane, at Post Ashta, Tk- walwa, Sangli,MS (1999-2000)			
1	**Area, acres**		5	
2	Row to Row Spacing, ft		3	
3	Spacing between pairs of Rows, ft		6	
4	Drip type: 16 mm Lateral with turbokey 4lph at 0.75m			
S.No.	**Particulars**			
			Drip	**Flood**
1	**Fixed Cost**		80000	0
	a. Life (years)		10	0
	b. Depreciation, Rs (10% of [1])	10%	8000	0
	c. Interest rate, Rs (15% of [1])	15%	12000	0
	d. Repair & Maintenance, Rs (2% of [1])	2%	1600	0
	e. Total (1b+1c+1d)		**21600**	**0**
	f. Fixed cost per acre, Rs =(1e/Area)		**4320**	**0**
2	Cost of Cultivation per acre,		25000	27000
3	Total Cost of Cultivation, Rs = (2)*Area		125000	135000
4	**Seasonal Total Cost (1e+3), Rs**		**146600**	**135000**
5	**Water Consumption,mm**		**1200**	**2000**
6	Yield of Produce, MT/acre		98	60
7	Total Yield of Produce, MT (6)*Area		492	300
8	Selling Price,Rs./Ton		1000	1000
9	Gross Income from produce,Rs = (7x8)		492000	300000
10	Net Seasonal Income,Rs = (9-4)		345400	165000
11	Gross Cost of Production,Rs		146600	135000
12	Total Gross Income,Rs		492000	300000
13	**Gross Benefit Cost Ratio = (12/11)**		**3.36**	**2.22**
14	Net Extra Income Due To Drip Over Conventional Irrigation = [10drip-10conventional]		**180400**	0
15	**Pay-Back Period, Years =(1/14)**		**0.44**	
16	**Water Use Efficiency, kg/ha mm.**		**202.54**	**74.10**

JAIN - KOMET RAIN GUN IRRIGATION SYSTEMFOR SUGARCANE

Rain guns are the latest development in sprinkler irrigation. These are sleek compact large sized sprinklers with long range and more versatile water delivery systems through interchangeable nozzles. The units are sturdy maintenance free and water lubricated. They are suitable for a variety of crops including sugarcane.

Raingun Twin95 Model working in a Sugarcane Field

Features

Rain guns are medium to high volume impact sprinklers. They are equipped with heavy duty construction with protected bearings. Light in weight these units are easy to install and have long wear life and very low maintenance. They are provided with a unique jet-breaker to provide uniform wetting pattern in the entire span of the water jet. The water distribution is uniform and less affected by wind compared to conventional sprinklers. These guns are suitable for both solid state and shiftable systems.

The guns come in full circle and part circle adjustments. Depending on the model, the pressure (ranging from 2-6 kg/cm2) and the nozzle selected the throw ranges from 19.5 m to 34.5 m for the smaller guns and upto 54 m to 70 m for bigger guns. For sugarcane the guns are fitted to tripod stands of 1.5m to 2 m height.

Installation of Raingun

Rain gun can be installed either as a Permanent system, or Semi-permanent system or Portable (shiftable) system in the cane field. In the permanent system guns are permanently installed in the field as per designed spacing. The initial cost is high but it saves labour cost required in handling and shifting.

In the semi-permanent system a pipeline network is installed permanently and outlets (hydrants) aare taken out at the desired spacing. Rainguns are mounted on to the hydrants.

In the portable mode the complete system of pipeline and gun are shifted from one place to another as per the design. The tripod fitted to a trolley system can also be used for shifting the guns.

The precipitation rate can be adjusted by pressure and or nozzle size. The precipitation rate must be determined considering the soil type and its infiltration rate to avoid ponding and wastage of water. For sugarcane an average precipitation rate is estimated as 16 to 18 mm for a period of 4 days.

Sakthi Sugars Limited
SIVAGANGA UNIT
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Sivaganga Taluk & Dist. PIN - 630 561
Phone : 04575 - 36206, 36204 Fax : 04575 - 36203
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SUGANE/E-6/ 656 /2002

April 8, 2002

Dr.P.Soman
Vice President - Project
M/s.Jain Irrigation Systems Limited
Jain Plastic Park
N.H.No.6, Bambhori
P.O.Box : 72
JALGAON - 425 001
India

Dear Sir,

Under the guidance and with partial financial assistance of M/s.Jain Irrigation Systems, a trial was laid out in the field of Thiru.K.K.R.Tamilarasu, Chokkanathapuram. I am providing the quantitative and quality parameters of sugarcane raised under drip and conventional methods of irrigation under paired row planting system for the kind reference.

Details	No. of IN	IN length (CM)	cane girth (CM)	cane length M	ind.cane Wt.(kg)	NMC/ acre	Brix %	Pol %	Pur. %	Rec. %	Yield (T/ac)	CCS (T/ac)
DRIP	33	9.87	2.79	3.26	2.01	53568	19.21	17.07	88.90	12.16	59.00	7.17
CONVEN-TIONAL	30	8.17	2.67	2.41	1.61	45952	19.86	16.78	85.67	11.81	36.00	4.25

Date of harvesting : 15.02.2002
Age at harvest : 12 months

Thanking you,

Yours faithfully,
For SAKTHI SUGARS LIMITED,

(J.STEPHEN ARUL)
ASSISTANT GENERAL MANAGER-CANE

Jain Irrigation Systems Ltd.
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