Fertigation in Sugarcane Production for Optimization of Water and Fertilizers Use

By

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Abstract

How the sugar world address "Fertigation" was reviewed. The primary objective was to compare different strategies, equipments, methods and timing being used to develop management practices on the efficient use of water and fertilizers in production of sugarcane, maximize yield, improve quality and reduce cost of production. The reference evapo-transpiration and the amount of water required for irrigating sugarcane plants were calculated according to its phenological stage. The results of this study support the general finding that the injection during the entire irrigation. Fertigation is a very efficient technique for conserving both water and nitrogen fertilizer and increasing crop production. Because fertigation offers several distinct advantages in comparison to conventional application methods, these are distribution of plant nutrients more evenly throughout the wetted root zone resulting in increased nutrient availability and uptake contributing to higher crop growth rates and cane yields, application of nutrients to the soil when crop or soil conditions would otherwise prohibit entry into the field with conventional equipment, no damage to the crop by root pruning, breakage of leaves, or bending of leaves as occurs with conventional fertilizer application methods/equipment, less energy is expended in application of the fertilizer, usually less labour and equipment are required for application of the fertilizer and to supervise the application.

Keywords: Sugarcane, Fertilizer, Irrigation, Injection, Fertigation, Productivity and Profitability

1. Introduction

Sugarcane being a giant crop producing huge quantity of biomass generally demands higher amounts of nutrient elements [1]. A large number of research experiments have clearly demonstrated that for producing higher cane and sugar yields on a sustainable basis application of adequate amounts of fertilizer nutrients viz. nitrogen, pho-sphorous and potassium is essential. Sugarcane is a high bio-mass producer in a sense that it is one of the most photo-synthetically efficient C4 plants. [2] reported that sugarcane can remove about 300 kg nitrogen/ha/season from the soil (126 Kg itrogen/feddan/season). [3] stated that the nitrogen requirement of sugarcane at Pongola in South Africa is greatest during the tillering (formative) phase. This is required for adequate tiller production and canopy development. Tillering in field grown sugarcane commences around 30 to 45 days after planting. Therefore, adequate N supply should be made available to the crop in the soil from the start of tillering phase. Further, [4] speculated that the crop requirement for N is higher in early grand growth period. This facilitates cane formation, checks tiller mortality and promotes cane growth. Application of more nitrogen at later phase of active crop growth period not only promotes late tiller formation, but also affects sugar recovery due to reduced juice sucrose percent, increase in soluble N in juice, water shoot formation besides attracting pests and diseases. Application of commercial fertilizers is an economic necessity on many soils to promote crop production with nitrogen, phosphorous and potassium being the common fertilizer elements [5]. Nitrogen promotes rapid succu-lent growth; phosphorus gives early root growth, blooming, and resistance to pest and weather damage. Potas-sium lends toughness and strength and pest resistance to plants [6].

Significant benefits from fertigation cannot be expected unless the irrigation system design is optimized to meet local soil conditions [7] and this should be the first consideration when appraising fertigation strategies for poor soils. Fertigation using furrow irrigation is a cost-effective and simple method of applying fertilizer across the field. In the past, fertigation has been associated with micro-irrigation and sprinkler irrigation systems. Injecting ni-trogen into irrigation water has become increasingly common for producers using surface irrigation. Potentially, fertigation enables surface irrigation producers a means to more readily attain recommended nitrogen manage-ment guidelines aimed at minimizing nitrogen losses from agricultural fields. Moreover, Beth and Filters [8] re-vealed that fertigation allows growers to apply nutrients in small amounts throughout the season in response to crop needs without the potential crop damage or soil compaction caused by machinery application methods. The introduction of fertigation technology (combined irrigation and fertilization) in modern agriculture opened up new possibilities for optimal water and nutrient supplies to crops and maintaining the desired concen-tration and distribution of ions and water in the soil. Fertigation is a key factor in modern intensive irrigated ag-riculture and can be practices under flood, furrow, and sprinkler irrigation [9]. At the same time, the costs of chemical fertilizers have increased and there is a need to improve fertilizer use efficiency for more benefits. The best answer to this challenge is “Fertigation”, where both water and fertilizers are delivered to crop simultane-ously through an irrigation system. Fertigation ensures that essential nutrients are supplied precisely at the area of most intensive root activity according to the specific requirements of sugarcane crop and type of soil resulting in higher cane yields and sugar recovery.

Playán and Faci [10] stated that when applying fertilizers through a fertigation system, there are several bene-fits. Applications can be targeted to specific areas, less equipment is used and fertilizer is applied into the soil, where it will be most effective. This means fertilizer can

be applied at a lower rate and be more efficient and in-expensive to suit the exact needs of the plant. With fertigation, compaction due to equipment travel is eliminated. Also, since heavy spreader equipment isn't needed out on the course, equipment costs are lowered drastically. The onetime cost of a fertigation system outweighs the multiple costs of spreading equipment and labour costs heavily. Not having to be out on the course also means that you can apply chemicals in conditions that would make conventional application damaging or impossible. When fertilizing through fertigation with a well planned and monitored schedule, there is less chance of leachable nutrients not being absorbed by the plant. Usually, the application can be applied with irrigation sche-946 D. M. Abdel Wahab dules so that the liquid fertilizer will only penetrate the first two to three inches of the soil. If timed right, deep percolation at application time is avoided meaning less likelihood of leaching. The chemistry of fertigation is essential factor in the success of the technique. Its scope covers interaction between fertilizers and irrigation water, behaviour in soil solution and rate of availability to plants, influence on soil structure, the compatibility of commercial fertilizers with application techniques, the composition of nutri-ent solutions and crop response. Most of the available studies rely on methods to assess the appropriateness of different fertigation strategies [11]. For optimization of fertilizers application, the nutrients supply will be ad-justed to the specific requirements of the crop in different phonological stages of growth and development. [12] stated that modern fertigation equipment (Fertilizer injection methods) must be used and should be able to regu-late quantity of fertilizer applied, duration of applications, proportion of fertilizes, and starting and finishing time.

[13] recommended that the fertilizer have to be injected at a constant rate during the entire irrigation event. This recommendation assumes that the tail water runoff will be blended with other water and reused in another field. On the other hand, [14] suggested that the fertilizer should be added during the end of the irrigation event to avoid deep penetration of fertilizers to the groundwater. Preliminary studies have indicated that the timing and duration of fertigation applications during the surface irrigation event play a critical role in determining the dis-tribution of fertilizer in the field and the potential movement of nitrate. This is mainly significant in light of evi-dence that suggests that fertigation may increase rather than decrease leaching of mobile chemicals from crop root zones. [15] conducted a series of fertigation experiments and concluded that the most effective fertigation application practice is expected to be related uniquely to the furrow irrigation method. They added that the infil-tration rate of the soil was the most important factor in the choice of injection strategy.

1.1. Benefits of Fertigation

Fertigation is a very efficient technique for conserving both water and nitrogen fertilizer and increasing crop production. Because fertigation offers several distinct advantages in comparison to conventional application methods which can be summarized as follow:

 Distribution of plant nutrients more evenly throughout the wetted root zone resulting in increased nutrient availability and uptake contributing to higher crop growth rates and cane yields.

 Application of nutrients to the soil when crop or soil conditions would otherwise prohibit entry into the field with conventional equipment.

 No damage to the crop by root pruning, breakage of leaves, or bending of leaves, as occurs

with conventional fertilizer application methods/equipment.

 Less energy is expended in application of the fertilizer.

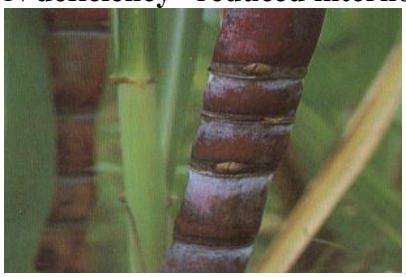
 Usually less labour and equipment are required for application of the fertilizer and to supervise the application.

Soil Fertility Status
Major Nutrients
98 % soils are deficient N
>80 % soils are deficient in P
>70 % soils are deficient in K
40-50% soils are deficient in Zn and B

Soil Fertility
Reasons of low soil fertility
Inherent
Leaching
Erosion
Fixation
Removal

How to assess
Soil Testing
Tissue Analysis
Fertilizer Trials
Deficiency Symptoms

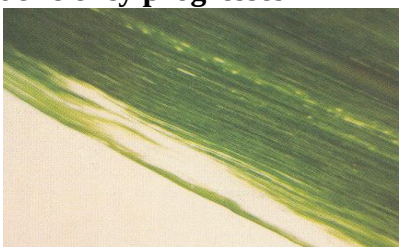
N deficiency "reduced internodes"



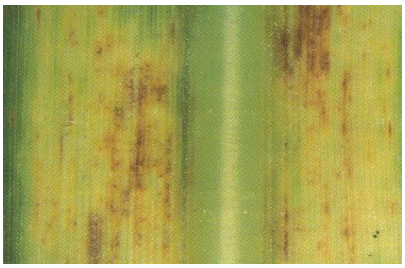
P deficiency

K stress "Bunched top"

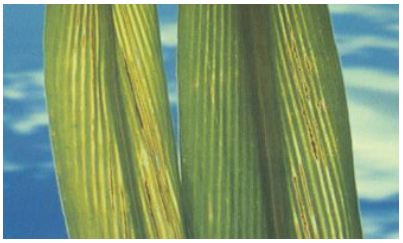
Water sacks along leaf margins as B deficiency progresses



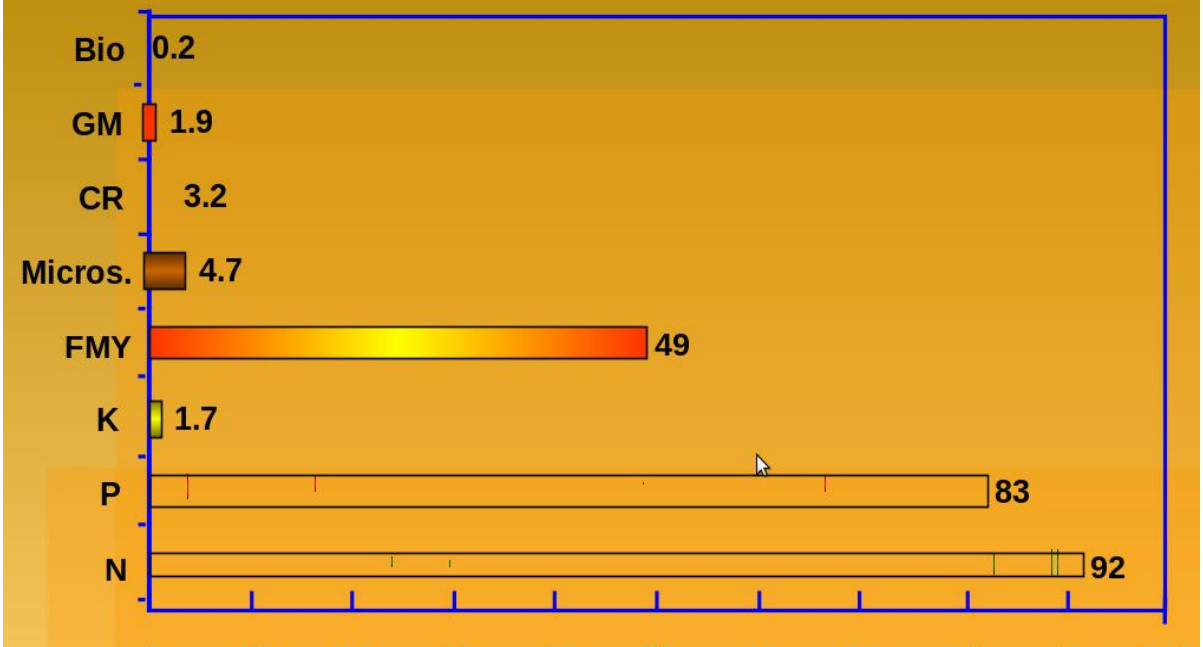
Zn deficient tissues with red lesions



Fe deficiency on high pH calcareous soils

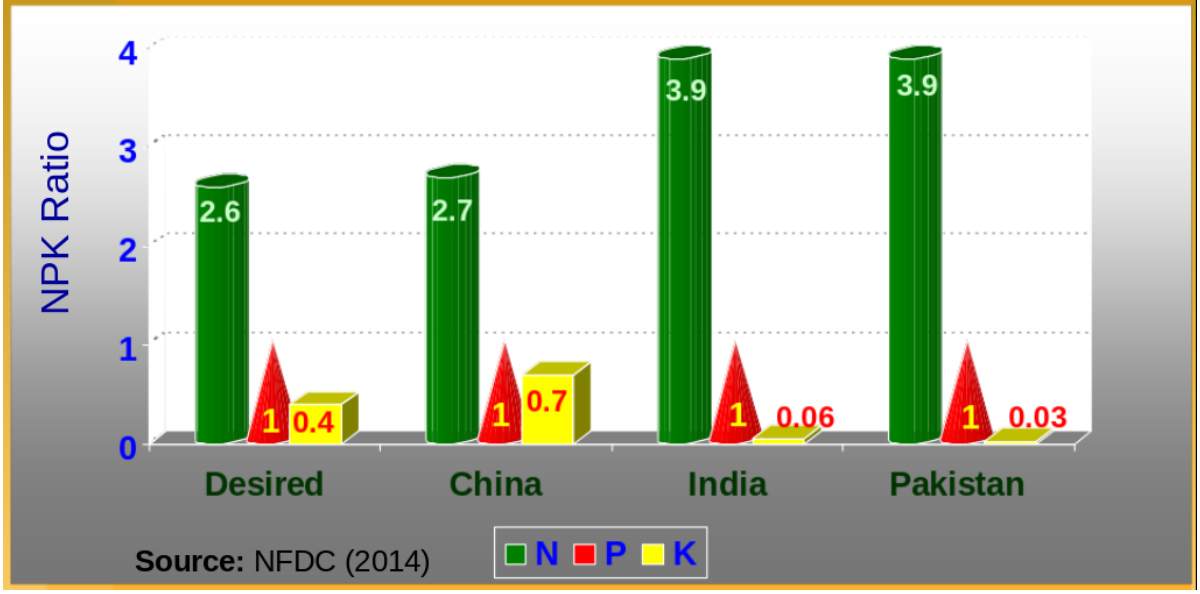


Nutrient Use Adoption by Farmers



Source: NFDC (2014)

Nutrient Use Ratio



Source: NFDC (2014)

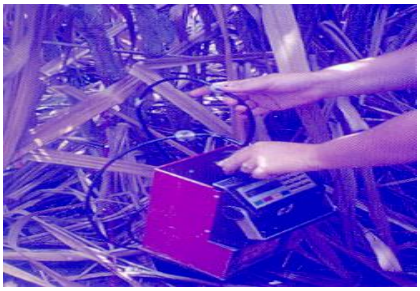
Fertigation Doze . . ?

Crop and Variety
Soil Condition/Type
(pH, CEC, OM, Wet-Dry condition, Soil Temp)

Management Practices
Nutrient status – Crop Loging
Type of fertilizer
Application method
Irrigation water availability

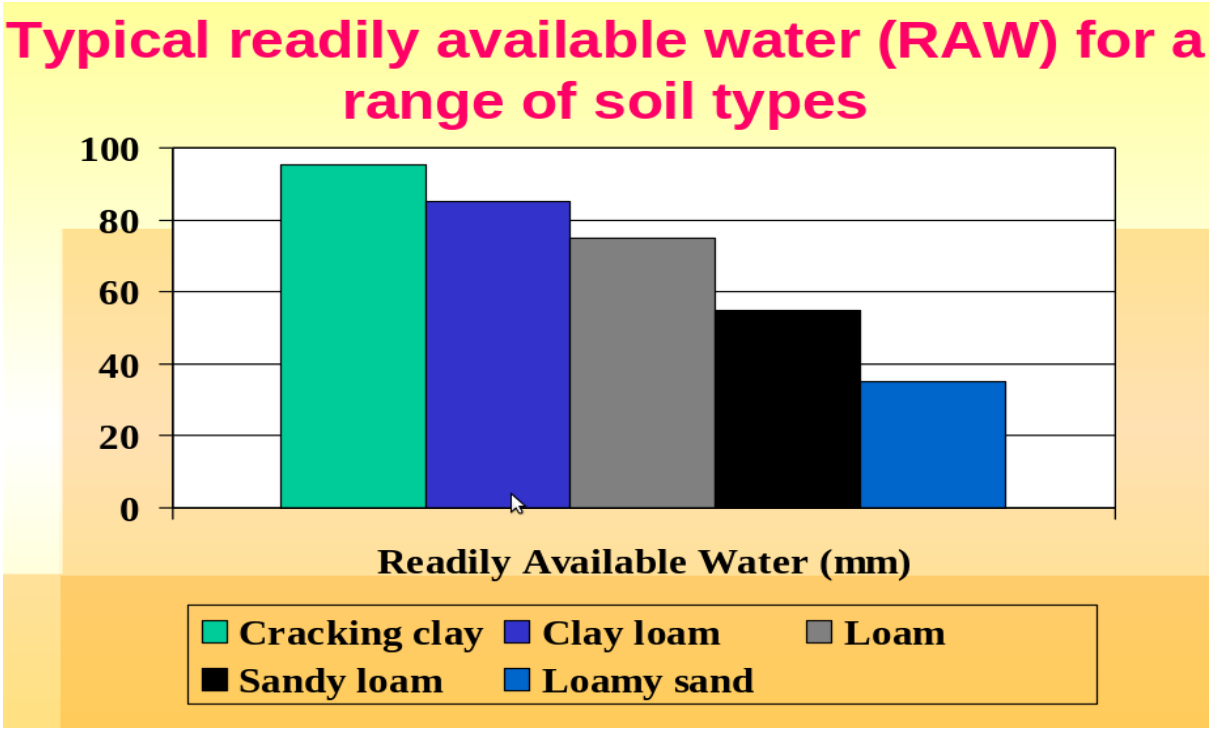
Fertigation Doze . . ?
Infiltration rate
Local rainfall data
Evaporation records
Irrigation scheduling
Drainage

Tensiometer



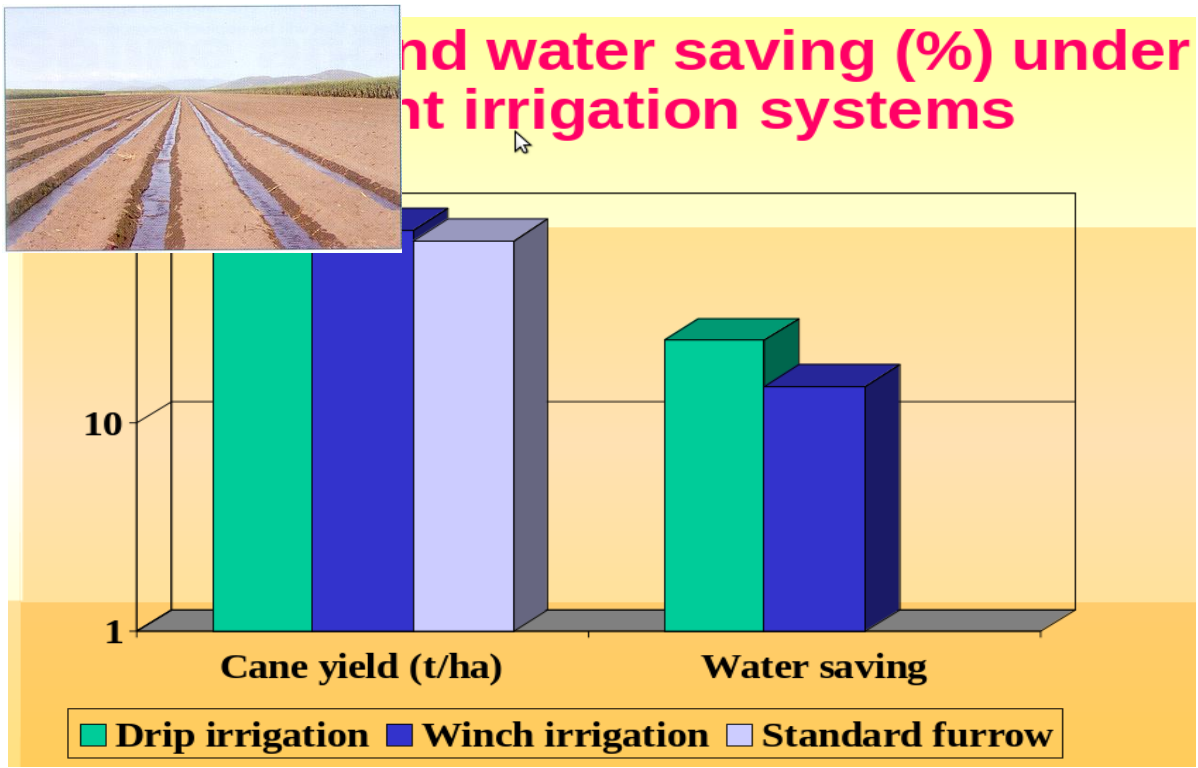
Neutron Hydro-probe

Enviro SCAN sensors



Fertigation systems

Surge Fertigation
Cannons Fertigation
Hand shift sprinkler
Lateral move fertigators
Center pivot fertigators
Drip fertigation



Individual furrow irrigation on a light textured soil

Lateral move Fertigator

Individual furrow Fertigation

Center Pivot Fertigator

Surge Fertigation showing surge valve and controller

Low pressure boom Fertigation

Water cannons, on well maintained two paths

A WINCH Fertigation on system in action

Impact of Management Practices on Sugar Yield Increase (%)

Management Practices	Sugar Yield
Stress tolerant varieties	10
Land leveling	15
Weed control	20
Fertigation	20

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