Effect of Some Techniques on Long Furrow Irrigation Efficiency

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***Abstract*—**This study was conducted at Kenana Sugar estate in three sites, site I with 250m furrow length and that of site II with 5oom furrow length, where as length furrow of 750m was site III. The treatments included four furrow irrigation techniques namely, cut-back, surge, cut-off and bunds. These irrigation techniques were tested at the three sites. The design adopted was the randomized complete block design with three replicates.

Results of the study showed that at site I, the highest application efficiency of 74% was obtained with surge flow, where as the lowest application efficiency of 59% was obtain by cut-off technique. At site II surge technique registered the highest application efficiency of 79% whereas, cut-off technique records the lowest application efficiency of 42%. At site III with 750m furrow length surge, cut back, bunds and cut-off techniques recorded 62%, 52%, 36% and 47% respectively. Results of the study also showed that at site I with 250m furrow length, distribution efficiencies of the four techniques recorded almost the same efficiency of 94, 92%, 89% and 93% for the surge, cut-back, cut-off and bunds technique respectively. At site II, surge and cut back techniques recorded 93%, cut-off registered 80%, whereas bund technique gave 91% distribution efficiency. At site III with 750m furrow length, surge technique registered the highest distribution efficiency of 94% where as cut-off technique recorded the lowest distribution efficiency of 76%..

***Keywords*—**Long Furrow, Irrigation, Efficiency.

I. Introduction

THE need for additional food supply and struggle for survival are necessitating a rapid expansion of irrigation throughout the world, even though irrigation is of first importance in the more arid regions of the earth. Water, being limited resource, its efficient use is basic to survival of the ever increasing population of the world.

Surface irrigation is one of the irrigation methods in which water is distributed over the field by over land flow. It is favored over other methods of irrigation (sprinkler, drip) on the basis of simplicity of maintenance and the use of unskilled Labor, minimum capital investment, although it is the historical choices of farmers but it is of low efficiency. Furrows are small charnels having a continuous nearly uniform slope and usually perpendicular to the field supply canal as cited by [6] and infiltration occurs vertically and laterally through the wetting perimeter of the furrow [8]. Furrow should be of as long as possible for better operation of farm machinery. [7] reported that optimum length of furrow is the longest furrow that can be safely and efficiently irrigated. Water distribution efficiency is simply a measured of the uniformity of water application along the run .The important characteristic of irrigation is uniform distribution of irrigation water throughout the root zone, more over uneven distribution has many undesirable characteristics such as drought areas appear in a field which is not irrigated uniformly and a tendency exist for salt accumulation. Application efficiency is the amount of water that is beneficially used by the crop divided by the total amount of water applied and it is usually low when using furrow irrigation [2]. [5] reported that under normal conditions application efficiency of surface irrigation are in the range of 40% to 65%.

There are many irrigation techniques which can be used to increase long furrow irrigation efficiency. These techniques include bunds, cut-back, cut-off and surge flow [1]. Bunds are strips made along the run or along the furrow so as to increase the duration between applying the water and infiltration, where as in cut-off irrigation technique the practice is to stop flow when the advance wetting front reached about 75% of the furrow. Surge flow was introduced by string ham and Keller (1979) under this method, irrigation is accomplished through series of individual pulses of water, Each surge as [8] reported is characterized by a cycle time and cycle ratio . The cycle time is comprised of an on time and off-time related by the cycle ratio. cut-back concept based upon applying a large initial non eroding stream size which can reach the lower end of the furrow in a short time, then the inflow stream should reduced as close as possible to a stream equal to the infiltration rate of the furrow .

Recently long furrow irrigation system has been introduced in the Sudan. Furrows of 180m length were reported in Tambul pilot scheme in 1971. The Rahad Scheme was planned for long furrow irrigation.

Kenana Sugar company practiced long furrow ranging from 180 up to 2000m, the field of the project suffers from over all irrigation efficiencies due to the high inflow rates and extremely long furrow run off problem, information's concerning long furrows irrigation in Sudan are rare for this reason this study was conduit to determine the irrigation

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technique which a lid increase long furrow irrigation efficiency.

II. Materials And Methods

The experiments were conducted at Kenana sugar company fields Sudan. 300 mile south of Khartoum at latitude 13° N and longitude 33° E about 41m above mean sea level .The climate is temperate with summer raining season . The mean maximum temperature is 40.6 c° and the mean minimum temperature is 13.7 c°, while relative humidity is between 20.5 and 79.8% [8] pH of the soil was (7.5 – 8.5) and the soil clarified as vertisols.

Three sets of experiments were conducted, furrow lengths of 250, 500 and 750m. Treatments studied included four long furrow irrigation techniques, namely, cut back, surge, cut-off and bunds. Each set of experiment included all techniques mentioned. The experiment design adopted was randomized complete block design with three replicates and treatment means were statistically analyzed .Moisture content was gravimetric determined.

Four uniform furrows with 1.55m spacing and 250, 500, 750m length was chosen for each technique. Stakes for 250m furrow length were set apart at 50m distance where as the stake set at 100m distance for the furrow of 500 and 750m length. Water head of 0.2m was maintained in supply canal. At this head a discharge of 2, 3 L\S was obtained. Two siphon tubes of discharge of 4.6 L\S were used to apply water to each furrow in the experiment.

Water application efficiency (Ea %) was calculated as follow

$$Ea\ \% = \frac{Ws}{Wf} \times 100$$

Where, Ea % = water application efficiency, as percent
Ws = the average depth of irrigation water stored in the root zone during irrigation
Wf = the average depth of irrigation water deliver to the farm

Distribution efficiency (Ed %) expresses the extent to which water was uniformly distributed along the run. This index was determined as following

$$Ed\ \% = (1- \frac{y}{d}\ )\ 100$$

Where, Ed% = water distribution efficiency, as percent
d = Average depth of water stored along the run during the irrigation
y = Average numerical deviation from (d).

III. Results And Discussion

Analysis of variance for application efficiency of the three sites studied were shown in table I., in which, site I with 250m furrow length showed a significant difference ($p \leq 0.05$) between the treatment means. Anon-significant difference observed between cut-back and bund techniques. Surge irrigation technique gave the highest application efficiency of 74% where as cut-off technique recorded the lowest 59% application efficiency.

At site II with 500m furrow length, a none-significant difference observed among surge, cut-back and bund irrigation techniques. Surge technique recorded the highest application efficiency of 79%, where as cut-off technique registered the lowest 42%.

At site III with 750m furrow, significant differences ($p \geq 0.05$) observed among the treatment means studied, anon- significant difference observed between cut-back and bund techniques. Surge technique registered the highest application efficiency of 62% and bunds technique recorded the lowest. Throughout the study the surge, and cut-back technique gave the highest application efficiencies. This may be attributed by the fact that surge technique offered greater opportunity time for water to infiltrate in the soil as cited by [4]. [3] reported that the hydraulic characteristic of the cut-back flow reduce run off losses and this leads to increase application efficiency further more. [1] stated that cut-back technique gave higher application efficiency than other traditional practices. Analyses of variance for distribution efficiency of the three sites studied were shown in Table II. At site I with 250m furrow length, there is a significant difference ($p \geq 0.05$) existed between the treatment means. Surge technique gave the highest distribution efficiency of 94% and cut-off technique recorded the lowest 75%. This may be due to the acceleration of the advance of surge flow. Similar result obtained by [9] who reported that the higher advance rate reduces the difference in intake rate opportunity time between the head of the furrow and the lower end , this give more uniform water distribution along the furrow.

At site II with 500m furrow length, from Table II, we can observed that there is significant difference existed between treatment means, a non-significant difference existed between surge and cut-back techniques and both recorded 94% distribution efficiency, cut-off and bunds technique recorded 79% and 90% respectively. This may attributed to the fact that cut-back techniques have high initial flow rate which causes high distribution efficiency.

At site III with 750m furrow length analysis of variance for distribution efficiency table II showed that a none significant difference ($p \geq 0.05$) observed under cut-back cut-off and bund techniques, surge flow recorded 94% distribution efficiency, where as cut-off registered 89%. This might be due to the reduction in deep percolation losses obtained when using surge flow, further more cut – off technique encourage water to escape by the cracks beyond the root zone.

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TABLE I
APPLICATION EFFICIENCY AT DIFFERENT SITES

Treatments	Site I	Site II	Site III
Surge	73.51a	79.25a	61.99a
Cut-back	66.60b	73.07a	52.13
Cut-off	58.69c	42.04b	36.55c
Bund	67.27b	68.93a	47.49b
S.E.±	2.13	4.90	2.89
L.S.D	4.82	11.08	6.54

TABLE II
DISTRIBUTION EFFICIENCY AT DIFFERENT SITES

Treatments	Site III	Site II	Site I
Surge	93.76a	93.22a	94.45a
Cut-back	83.67b	92.57a	91.67ab
Cut-off	75.82b	79.72b	89.04b
Bund	85.53ab	90.73a	93.16ab
S.E.±	4.37	4.10	1.92
L.S.D	9.87	9.26	4.34