Sugarcane Crop Water Requirement and Irrigation Scheduling Based on Planting Dates at Kenana Sugarcane Plantation

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Abstract: *This study was conducted at the sugarcane fields of Kenana Estate, Sudan in the long furrow irrigation system established in a montmorillonitic clay soil, during the two successive seasons 2000 and 2001. In attempt to find out a new trend of crop water requirement calculation and irrigation indenting. The sugarcane habit adopted in Kenana has been the main source of the study concept. Since the sugarcane planting is a continuous process before and during harvesting, the cane plant and ratoon crop were divided into different categories. The crop water requirement (CWR) was calculated, based on the study of reference evapotranspiration (ET_o), using Penmen-Montieth Approach and the CROPWATT Software. ET_o of the same month was used with different monthly crop coefficients (kc) to get the net crop water requirement (NCWR) for 5 categories of plant cane (Oct.-, Nov.-, Dec.-, Jan.- and Feb.-planting) and 6 categories of ratoons (Nov.-, Dec.-, Jan.-, Feb.-, Mar.- and April-ratooning) based on planting dates. This indicates that in all categories of plant cane and ratoon crop of 2000 and 2001, the monthly NCWR were low in the first months of initial stage, and increased with crop development until it reached its maximum in boom stage (4,5,6 and 7months of crop age), particularly, if it is coincided by hot summer months (March and April) then declined to a minimum in the rainy months from July to September and increased again after end of rains in both seasons the highest and lowest net crop water requirements (NCWR) were recorded in March and July respectively. generally, when grouping the months of the two growing seasons to A (Oct. – Feb.), B (March – June) and C (July – Sept.) group. Group A represent the months of seasons overlapping which has high NCWR, however group B which represent the dry summer months, has the highest NCWR, then group C (rainy months) has the lowest NCWR.*

Keywords: *sugarcane, furrow, crop water requirement, , plantcane, ratoon crop, evapotranspiration , crop coefficients.*

1. Introduction

Kenana Estate is one of the six scattered complexes of sugarcane established in the hot dry environment of central Sudan. With its largest sugar factory in Africa, Kenana was conceived with an objective of securing Sudan and Arab World supplies. Sugar was first produced in significant quantities reaching 387,000 MT in 1999/2000 representing 70% of the total sugar production in the Sudan. The White Nile is the water source for three sugar complexes Kenana, Assalaya and White Nile. The seasonal discharge of the White Nile river is varying as highest in November with an average of 1176 m3/sec. and lowest in April with 515m^3/sec. Irrigation in Kenana sugar estate is the most costly item, its cost has been estimated to be around 60% of the total cost of cane production. The irrigation net work consists of six pumping stations situated along the main canal, the irrigation water in the main canal is diverted into the primary canals and the latter supply the field canals from which the irrigation water is directly conveyed to the furrows using gated pipes (Hydroflumes). Irrigation practices in Kenana has been subjected to many changes from establishment till a day at which the water indenting was based on fixed days per cycle with different sizes of siphons in the same field, then changed to be based on evapotranspiration (10 mm/day), then based on the number of operating pumps and finally based on the steepness and furrow length where the estate fields were divided into three categories A, B and C to receive water every 12, 10 and 7 days, respectively. Sugarcane is a tall perennial grass with long coarse leaves springing from the nodal points of an unbranched stalk. Its average height varies between 2.5 and 3.5 meters. It grows

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from stools established from cuttings of stalk and growth habits vary with variety (Bates, 1963). The first reaping of sugarcane (plant crop) is usually taken 12 to 24 months after planting. After that, successive crops referred to as ratoons, are reaped at intervals of about 12 months. The plant crop yield is about 30 to 50 or even 80 tons per acre in exceptional cases (Bates, 1963). Ratoon harvests are usually progressively smaller and in due course it becomes necessary to replant. Primary factors for cane yield are the stalk population and weight (Irvine and Benda, 1980). The ideal climate is a long warm growing season and fairly dry sunny and cool period for good maturity but free from frost, hurricanes or strong winds (Humbert, 1968). Sugarcane needs an average precipitation of 1200 to 1500 mm per year but tolerates much higher amounts, although excess water reduces cane and sugar yield (Carter, 1976). Humbert (1983) in Hawaii showed that the average water-use rate for sugarcane was about 6 mm/day. During the "boom" stage of growth in the hot summer months, the maximum water-use rate was about 8 mm/day while in the cloudy winter months, water-use rate declined to about 3 mm/day. Many research workers stated that a ton of water is required to make one pound of sugar on the irrigated plantations of Hawaii (Humbert, 1968). He also concluded that, the frequency of irrigation depends on the stage of growth of the cane. Light, frequent irrigations are preferred when the seed is germinating and the young seedlings are getting established. As the root system extend into deeper soils, the irrigation intervals should be extended, and the amount of water applied with each irrigation increased. As the cane approaches maturity, extended irrigation intervals are scheduled to reduce the rate of vegetative growth, dehydrate the cane, and force the conversion of reducing sugars to recoverable sucrose. Adam and Farbrother (1977) stated that the crop water use is a complex function involving a large number of parameters concerning the weather, the status of available soil moisture, and the growth and development of the crop itself. Adam (1992) reported that the traditional irrigation indenting system is based upon determination of crop water requirements as a function of climate, soil and crop factors. The net crop water requirement (NCWR) is the amount of water needed to supplement the effective rainfall in the crop root zone. Effective rainfall is that portion of rainfall that contributes to meeting the evapotranspiration requirement of a crop (Hershfield, 1964). Generally, the crop water requirement of sugarcane in Sudan increases gradually with plant development and reaches its peak during summer months but declines at the end of the growing season (Farbrother, 1973; Fadl, 1977 and Abd Elrasool et al., 1977). The objective of this study was to find out an ideal indenting of irrigation, based on different categories of sugarcane-crop water requirement for different areas.

2. Materials and Methods

The study was conducted in the sugarcane fields of Kenana Sugar Estate, in coordination with Kenana Research Centre (KRC). Kenana Scheme is located 300 km south of Khartoum on the eastern bank of the White Nile 30 km South-east Rabak town, at the intersection of Latitude 13º 10″ North and Longitude 32º 40″ East, at an altitude of 410 m above mean sea level. Kenana soil is a vertisol, which is mainly an alluvial sediment of the Blue Nile, derived mostly from the basic igneous rocks of the Ethiopian Highlands. It is part of the central clay plain, which dips gently to the White Nile plain. In general, the soil is dark cracking with high clay content ranging from 60 to 70%, predominantly montmorillonite. The soil is thus characterized by high swelling and shrinking characteristics "self mulching clay", with extremely low infiltration rate, 0.00005 m3 m-1 min-1 (Abdelwahab, 2000). The soil is non-saline, non-sodic with high CEC and its pH ranges from 7.5 to 8.5. Kenana soil is classified as very fine, smectitic, isohyperthermic Typic Chromusterts (Soil Survey Staff, 1977). The irrigation water of the White Nile is a high water quality (C1S1)(Ali, 1998). The climate of the study area is tropical aridic with a cool dry winter season (November–February), a hot dry summer season (March–June), and a hot rainy season (June–October). The mean annual rainfall is 359 mm (1977-2001). During winter, the mean temperature ranges from 15.8 to 35.3ºC, and in summer, it ranges from 21.8 to 38.7ºC and in autumn, it ranges from 22.1 to 34.6ºC. In Kenana, the first reaping of plant cane and ratoon crop usually taken 14 and 12 months after planting, and irrigated to 13 and 11 months, respectively. Crop water requirement (CWR) for the two seasons (2000 and 2001) were calculated for plant cane and ratoons. The cane crop for both seasons is categorized into five groups of plant cane and six groups of ratoons according to planting and ratooning dates, respectively. The crop water requirement for each group was then calculated for each month according to the following equation:

$$CWR = kc \times ET_o \times \text{days of the month} \tag{1}$$

Where: ETo = reference evapotranspiration, mm/day.

kc = crop coefficient.

The plant cane and ratoons crop coefficients used were developed by El-Fadni (1990) were as follow:

Cane age (months)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Plantcane crop coefficient (kc)	0.6	0.7	0.9	1.1	1.3	1.3	1.25	1.2	1.1	1.1	1.1	1.1	1.1	1.0	0.9
Ratoon crop coefficient (kc)	0.6	0.6	0.8	1.1	1.3	1.2	1.0	1.0	1.0	1.0	1.0	0.9	0.9	-	-

Then the monthly net crop water requirement (NCWR) was calculated by subtracting the monthly effective rainfall (ERF) as:

$$NCWR = CWR – ERF \tag{2}$$

The ETo data for the two seasons were computed by CROPWAT Program using pertinent meteorological data, based on the Penman-Montieth equation as suggested by Smith et al. (1991) as follow:

$$ET_0 = \frac{0.408\Delta(Rn - G) + \gamma \frac{900}{T+273} U_2 (ea - ed)}{\Delta + \gamma(1 + 0.34U_2)} \tag{3}$$

Where: ET_o = reference evapotranspiration (mm day-1)

Rn = net radiation at crop surface (Mj m-2 day-1).

G = soil heat flux (Mj m-2 day-1).

T = average temperature at 2 m height.

(ea – ed) = vapor pressure deficit for measurement at 2 m height.

U2 = wind speed (km.day-1)

Δ = slope of vapor pressure curve (k Pa ºC)

γ = Psychrometric constant (k Pa ºC)

900 = Coefficient for the reference crop (kj kg day-1).

0.34 = wind coefficient for the reference crop (Sm-1)

The effective monthly rainfall (ERF) was calculated from the total rainfall (TRF, mm) according to the following USDA conservation service (Doorenbos et al., 1986) empirical relationships.

$$ERF = TRF\,(125 – 0.2TRF)/125 \quad \text{(for TRF < 250 mm).} \tag{4}$$

$$ERF = 125 + 0.1\,TRF \quad \text{(for TRF > 250 mm).} \tag{5}$$

3. Results and Discussion

Tables 1 show the climatic data for the years 2000 and 2001, respectively. From these data the evapotranspiration (ETo) for the mean annual years 2000 and 2001 were 5.6 and 5.5 mm/day, respectively. Table 2 shows the total (TRF) and effective rainfall (ERF) for the years 2000 and 2001. The total effective rainfalls were 358.8 mm and 300.3 mm, respectively. The peak ERF were recorded in July in the two successive seasons as 112.0 and 120.3 mm. Tables 3, 4, 5 and 6 show the monthly NCWR for different areas of the corresponding categories of plant canes and ratoons for the two seasons 2000 and 2001 as well as the total monthly NCWR for the different categories throughout the irrigation seasons. Table 3 shows the total NCWR for the 1^3 months for plant cane 2000 as 95101400 m^3 for an area of 11385 feddans in an average of 8353.2 m^3/fed, whereas, for the plant cane 2001 was 94967300 m^3 for an area of 11328 feddans, in an average of 8383.4

m^3/fed. (Table 5). Table 4 shows the total NCWR for the 11 months for ratoons 2000 as 391137800 m^3 for an area of 65591 fed. in an average of 5963.3 m^3/fed. Whereas, for the ratoons of 2001 was 386993500 m^3 for an area of 64042 fed. in an average of 6042.8 m^3/fed. (Table 6). This variation of NCWR for plant cane and ratoons between the two years were due to the variation in climatic conditions (ETo and ERF). Table 7 shows that the trend at which the total monthly NCWR for the plant cane and ratoons of season 2000 and 2001 compose the total monthly NCWR for the whole project during the two seasons and shows the months at which these plant canes and the ratoons of season 2000 overlap with that of season 2001. The monthly total NCWR for the whole scheme throughout the two seasons from October 1999 to February 2002 were calculated. Then they were divided into three groups of months as A, B and C group. Group A represent the five months from October 2000 to February 2001 as a months of seasons overlapping at which the cane crops of the two seasons 2000 and 2001 are still under irrigation, the monthly NCWR for this group ranged from 41485400 in November 2000 to 31011600 m^3 in October 2000 with a mean of 36880320 m^3. Group B follow group A and represent the dry summer season months from March to June at which the ETo is the highest due to the high temperature. In these months the total monthly NCWR ranged from 61470000 m^3 in April 2000 to 53636200 m^3 in May 2000 with the mean of 58170525 m^3 for season 2000, whereas the same B group for the season 2001 ranged from 63275700 m3 in May 2001 to 45467100 m^3 in June 2001 with a mean of 54740975 m^3. Group C represents the three rainy months from July to September at which the minimum NCWR were recorded. The NCWR for the months from July to September 2000 ranged from 23499500 m^3 in August 2000 to 17653500 m^3 in July 2000 with a mean of 20372567 m^3. whereas, the same C group from July to September 2001 ranged from 35427000 in September to 11498100 m^3 in July with a mean of 21033533 m^3. Generally, the water requirements of the sugarcane crop (plant cane and ratoon) increase gradually with plant development until reaches its peak during summer months (March and April) and declines at the rainy season (July and August) to the minimum, these were showed clearly in Fig. 1. These results were in line with that mentioned here before as reported by Farbrother (1973), Fadl (1977) and Abd Elrasool et al. (1977). If the NCWR based on the peak, it can be as 290.2 mm/month after subtracting the effective rainfall it can be equivalent to 143380.0 and 11900.3 m^3/fed./season for plant cane and ratoon of season 2000 respectively and as 266 mm/month equivalent to 13262.3 and 11027.9 m^3/fed./season for plant cane and ratoon, respectively, for season 2001. The grouping of the 5 plant cane and the 6 ratoon categories revealed that the plant cane and ratoon planted in October and November reached the highest NCWR in March and April of the two seasons 2000 and 2001.

4. Conclusion

The study concluded that the group of months of the two successive seasons shows clear trend of variation in the season overlapping months (group A), summer months (group B) and the rainy months (group C). These two variables should therefore, be taken into consideration when indenting the irrigation in different areas at different months during the growing season.

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TABLE 1: Mean Monthly Meteorological Data and Mean Monthly Reference Evapotranspiration Data Calculated According to (Penman-Monteith) for the Period 2000 and 2001 In KRC.

Month	T.min (C°)	T.max (C°)	Relative humidity %	Wind speed (km/day)	Sun shine (hr)	Radiation ($Hj/m^2/day$)	ET_o (mm/day)	T.min (C°)	T.max (C°)	Relative humidity %	Wind speed (km/day)	Sun shine (hr)	Radiation ($Hj/m^2/day$)	ET_o (mm/day)
	Year 2000							Year 2001						
Jan.	15.5	34.8	44	176	10.1	21.1	5.7	13.6	32.0	48	168	10	21.0	5.1
Feb.	17.3	36.1	36	185	10.3	23.2	6.5	15.8	34.9	30	173	10.0	22.7	6.2
Mar.	17.5	37.5	27	183	10.4	25.0	7.2	21.0	38.0	27	151	9.0	22.8	6.6
Apr.	22.6	39.8	34	123	9.2	24.7	6.5	23.0	41.4	29	111	10.0	25.0	6.6
May	24.5	39.4	55	119	8.4	22.2	6.0	25.2	41.2	38	108	9.0	23.2	6.3
Jun.	24.4	38.5	61	159	9.2	23.9	6.4	24.0	35.4	62	146	8.0	21.3	5.6
Jul	22.4	34.6	76	154	6.1	18.6	4.8	22.7	34.0	77	125	6.0	18.4	4.5
Aug.	21.8	30.2	84	133	6.2	18.9	4.1	22.2	30.9	84	127	6.0	18.6	4.1
Sept.	22.1	32.9	79	113	7.9	21.2	4.7	22.0	33.8	76	97	8.0	21.3	4.8
Oct.	21.3	35.6	65	92	8.7	21.1	4.8	21.9	37.6	59	93	9.0	21.5	5.1
Nov.	19.0	36.6	42	117	10.3	21.7	5.2	19.6	35.8	38	111	11.0	22.6	5.1
Dec.	15.5	33.3	42	153	10.3	20.8	5.1	17.1	35.4	40	163	10.0	20.3	5.5
Year.	20.9	35.8	57	135	8.7	21.7	5.6	20.7	35.9	51	131	8.8	21.6	5.5

TABLE 2: Mean monthly rainfall data at K.S.C. climatic station for the period 2000 and 2001 and effective rainfall according to USDA S.C. method

Month	Total rainfall (mm/month)	Effective rainfall (mm/month)	Total rainfall (mm/month)	Effective rainfall (mm/month)
	2000		2001	
Jan.	0.0	0.0	0.0	0.0
Feb.	0.0	0.0	0.0	0.0
Mar.	0.0	0.0	0.0	0.0
Apr.	0.0	0.0	0.0	0.0
May	30.5	29.0	4.0	4.0
Jun.	25.3	24.3	44.7	41.5
Jul	146.2	112.0	162.7	120.3
Aug.	74.9	65.9	106.3	88.2
Sept.	101.5	85.0	41.0	38.3
Oct.	46.0	42.6	8.0	7.9
Nov.	0.0	0.0	0.0	0.0
Dec.	0.0	0.0	0.0	0.0
Total	424.4	358.8	366.7	300.3

TABLE 3: The net water requirement of plant cane seeded in various fields at different months (2000)

Month	Oct. 1999	Nov. 1999	Dec. 1999	Jan. 2000	Feb. 2000	Monthly Total
NCWR (1000m^3)						
Area	482	3443	3467	2997	996	11385.0
Oct. 1999	152.2					152.2
Nov.	221.1	1353.5				1574.6
Dec.	288.1	1600.8	1381.9			3270.7
Jan. 2000	393.5	2299.2	1801.2	1334.3		5828.3
Feb.	479.0	2895.0	2385.2	1603.6	456.8	7819.6
Mar.	587.5	4196.5	3574.8	2528.8	653.4	11541.0
Apr.	513.2	3665.8	3691.3	2700.0	734.2	11304.4
May	393.1	3077.2	3098.7	2678.6	734.6	9982.2
Jun.	378.4	2980.3	3280.7	2835.9	942.5	10417.8
Jul.	104.7	747.6	969.8	1024.6	340.5	3187.2
Aug.	149.6	1068.6	1076.1	1090.1	415.4	3799.8
Sep.	141.9	1013.7	1020.8	882.4	352.2	3411.0
Oct.	245.2	1751.2	1763.4	1524.3	506.6	5790.6
Nov.		2481.4	2498.7	2160.0	717.8	7858.0
Dec.			2532.2	2188.9	727.5	5448.6
Jan.2001				2188.9	727.5	2916.4
Feb.					799.0	799.0
Total	4047.4	29130.9	29074.7	24740.5	8107.9	95101.4

- Data of cultivated area, (2000 and 2001) were taken from Kenana Production Management Office.

TABLE 4: The net water requirement for the ratoon crops planted various fields at different months (2000)

Month	Nov. 1999	Dec. 1999	Jan. 2000	Feb. 2000	Mar. 2000	April 2000	Monthly Total
NCWR (1000m^3)							
Area	9355.0	12508	10523	11338	12354	9513	65591.0
Nov. 1999	3677.6						3677.6
Dec.	3728.7	4985.4					8714.2
Jan. 2000	5555.7	5568.6	4684.8				15809.1
Feb.	7866.1	7648.9	4826.3	5200.1			25541.3
Mar.	11402.2	12897.0	7893.5	6376.3	6947.6		45516.7
Apr.	9194.1	13317.3	9480.2	7428.7	6070.8	4674.7	50165.6
May	6168.7	10202.0	9405.0	8362.0	6216.0	3300.3	43654.0
Jun.	6589.1	8809.9	9108.9	10728.7	9697.6	5166.1	50100.4
Jul.	1445.9	1933.2	1626.4	3171.5	4223.6	2065.7	14466.3
Aug.	2404.6	3215.1	2704.8	2914.3	4493.4	3967.5	19699.7
Sep.	2200.3	2941.9	2475.0	2666.7	2905.7	3364.2	16553.7
Oct.		5579.1	4693.7	5057.2	5510.4	4243.2	25083.5
Nov.			6894.7	7428.7	8094.3	6232.9	28650.6
Dec.				7528.7	8203.3	6316.8	22048.8
Jan.2001					8203.3	6316.8	14520.1
Feb.						6936.1	6936.1
Total	60233.1	77098.3	63793.4	66862.7	70566.0	52584.3	39.1137.8

TABLE 5:The net water requirement of plant cane seeded in various fields at different months (2001)

Month	Oct. 2000	Nov. 2000	Dec. 2000	Jan. 2001	Feb. 2001	Monthly Total
NCWR (1000m^3)						
Area	701	3702	2082	3585	1258	11328.0
Oct. 2000	137.5					137.5
Nov.	321.5	1455.3				1776.8
Dec.	419.0	1721.2	829.8			2970.0
Jan. 2001	512.0	2212.5	968.0	1428.9		5121.4
Feb.	664.5	2969.7	1365.9	1829.4	550.6	7380.1
Mar.	783.2	4135.9	1968.4	2772.0	756.6	10416.0
Apr.	757.8	4002.2	2250.8	3279.4	941.5	11231.8
May	678.3	3885.5	2185.2	3762.7	1113.8	11625.6
Jun.	421.9	2489.3	1546.9	2663.6	934.7	8056.3
Jul.	97.7	516.2	411.9	920.0	322.8	2268.6
Aug.	151.9	802.3	451.2	968.2	406.8	2780.4
Sep.	353.6	1867.4	1050.2	1808.3	710.6	5790.2
Oct.	488.7	2581.0	1451.6	2499.5	877.1	7897.9
Nov.		2616.8	1471.7	2534.1	889.2	7511.8
Dec.			1640.4	2824.7	991.2	5456.3
Jan.2002				2618.4	918.8	3537.2
Feb.					1009.2	1009.2
Total	5787.7	31255.4	17592	29909.2	10423.0	94967.3

TABLE 6:The net water requirement for the ratoon crops planted various fields at different months (2001)

Month	Nov. 1999	Dec. 1999	Jan. 2000	Feb. 2000	Mar. 2000	April 2000	Monthly Total
NCWR (1000m^3)							
Area	9355.0	12508	10523	11338	12354	9513	65591.0
Nov. 1999	3677.6						3677.6
Dec.	3728.7	4985.4					8714.2
Jan. 2000	5555.7	5568.6	4684.8				15809.1
Feb.	7866.1	7648.9	4826.3	5200.1			25541.3
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Apr.	9194.1	13317.3	9480.2	7428.7	6070.8	4674.7	50165.6
May	6168.7	10202.0	9405.0	8362.0	6216.0	3300.3	43654.0
Jun.	6589.1	8809.9	9108.9	10728.7	9697.6	5166.1	50100.4
Jul.	1445.9	1933.2	1626.4	3171.5	4223.6	2065.7	14466.3
Aug.	2404.6	3215.1	2704.8	2914.3	4493.4	3967.5	19699.7
Sep.	2200.3	2941.9	2475.0	2666.7	2905.7	3364.2	16553.7
Oct.		5579.1	4693.7	5057.2	5510.4	4243.2	25083.5
Nov.			6894.7	7428.7	8094.3	6232.9	28650.6
Dec.				7528.7	8203.3	6316.8	22048.8
Jan.2001					8203.3	6316.8	14520.1
Feb.						6936.1	6936.1
Total	60233.1	77098.3	63793.4	66862.7	70566.0	52584.3	39.1137.8

TABLE 7: Monthly total net crop water requirement for plant cane and ratoon (2000) and (2001)

Month	Plant cane 2000	Ratoons 2000	Plant cane 2001	Ratoons 2001	Total	Months group
	NCWR (1000m^3)					
Oct. 1999	152.2				152.2	A_1
Nov.	1574.6	3677.6			5252.2	
Dec.	3270.7	8714.2			11984.9	
Jan. 2000	5828.3	15809.1			21637.4	
Feb.	7819.6	25541.3			33360.9	
Mar.	11541.0	45516.7			57057.7	B Summer months x = 58170.5
Apr.	11304.4	50165.6			61470	
May	9982.2	43654.0			53636.2	
Jun.	10417.8	50100.4			60518.2	
Jul.	3187.2	14466.3			17653.5	C Rainy month x = 20372.6
Aug.	3799.8	19699.7			23499.5	
Sep.	3411.0	16553.7			19964.7	
Oct.	5790.6	25083.5	137.5		31011.6	A Season overlapping months x = 36880.3
Nov.	7858.0	28650.6	1776.8	3200.0	41485.4	
Dec.	5448.6	22048.8	2970.0	7686.6	38154	
Jan.2001	2916.4	14520.1	5121.4	13304.4	35862.3	
Feb.	799.0	6936.1	7380.1	22773.1	37888.3	
Mar.			10416.0	39527.5	49943.5	B Summer months x = 54741.0
Apr.			11231.8	49045.8	60277.6	
May			11625.6	51650.1	63275.7	
Jun.			8056.3	37410.8	45467.1	
Jul.			2268.6	9229.5	11498.1	C Rainy months x = 21033.5
Aug.			2780.4	13395.1	16175.5	
Sep.			5790.2	29636.8	35427	
Oct.			7897.9	35265.2	43163.1	A_2
Nov.			7511.8	28761.0	36272.8	
Dec.			5456.3	23898.4	29354.7	
Jan.2002			3537.2	14939.1	18476.3	
Feb.			1009.2	7270.1	8279.3	
Total	95101.4	391137.8	94967.3	386993.5	968200.0	
	486239.2		481960.8		968200.0	

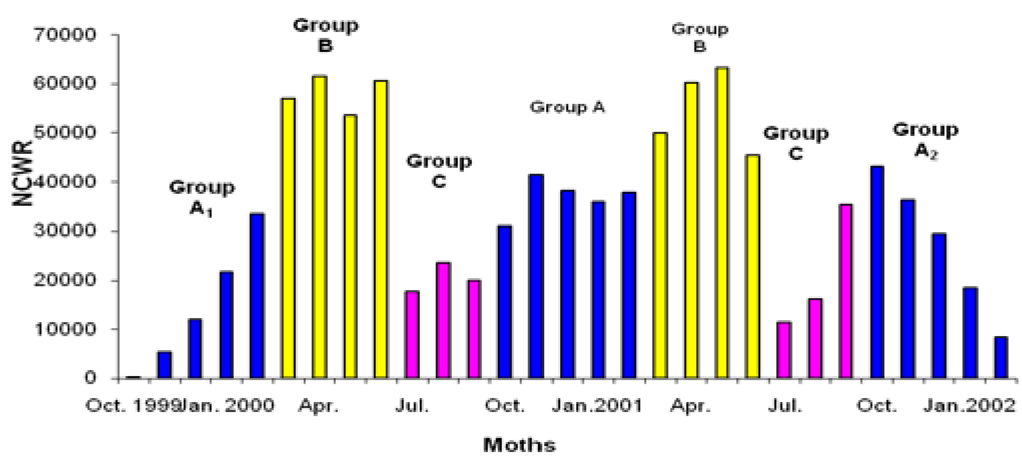

Fig. 1. Monthly total net crop water requirement for plant cane and ratoon and the different groups of months (2000) and (2001)

Fig. 1: Group A1 and A2 represent the NCWR at the beginning of season 2000 and end of season 2001, respectively pure without adding the months of overlapping

تحديد الاحتياجات المائية لمحصول قصب السكر اعتمادا علي تواريخ الزراعة في مشروع سكر كنانة

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أجريت هذه الدراسة في حقول قصب السكر بمشروع سكر كنانة بالسودان، في نظام الري بالسراب الطويل والذي أنشأ في التربة الطينية المونتموريلونيتية خلال الموسمين المتتاليين 2000-2001 في محاولة لإيجاد منحي جديد لحساب الاحتياجات المائية للمحصول وجدولة الري. الطريقة المتبعة لزراعة قصب السكر في كنانة كانت المصدر الأساسي لفكرة الدراسة، فبما أن عملية الزراعة كعملية مستمرة قبل وأثناء الحصاد فقد تم تقسيم نبات القصب والخلفات إلي أقسام مختلفة. الاحتياج المائي للمحصول قد حسب اعتماداً علي دراسة البخرنتح المرجعي (ETo). البخرنتح المحسوب لذات الشهر قد أستعمل CROPWATT software) باستعمال قاعدة بنمان مونتيس المعدلة ونظام (kc) مع عوامل محصولية شهرية مختلفة (NCWR) لإيجاد صافي الاحتياج المائي المحصولي (لخمس أقسام لنبات القصب (زراعة أكتوبر، نوفمبر، ديسمبر، يناير وفبراير) وستة أقسام للخلف (تخليف نوفمبر، ديسمبر، يناير، فبراير، مارس وأبريل) اعتماداً علي تاريخ الزراعة بعد طرح كمية الأمطار الفعالة (ERF) وقد حددت الدراسة في جميع الأقسام لنبات القصب والخلفات للموسمين لها صافي احتياج مائي محصولي منخفض في الشهور الأولي للطور الابتدائي ثم زاد مع تطور المحصول إلي أن وصل حده الأعلى في مرحلة اكتمال النمو الخضري (Boom stage)(في 4، 5، 6 و7 شهور من عمر المحصول) خاصة إذا صادف هذا الطور شهور الصيف الحارة (مارس وأبريل). ثم انخفض للحد الأدنى في شهور ممطرة (يوليو إلي سبتمبر) ثم ارتفع مرة أخري بعد نهاية الأمطار. في الموسمين صافي الاحتياج المائي المحصولي الأعلى والأدنى كان في شهري مارس ويوليو علي التوالي. عموماً عند تقسيم شهور الموسمين الزراعيين إلي مجموعة A (يوليو-سبتمبر)، فإن المجموعة C (مارس-يونيو) وB(أكتوبر-فبراير)، تمثل شهور تداخل المواسم و بها احتياج مائي محصولي عالي، المجموعة B تمثل شهور الصيف و بها أعلي احتياج مائي ثم