ALTERNATE SKIP IRRIGATION STRATEGY ENSURE SUSTAINABLE SUGARCANE YIELD

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ABSTRACT

Skip irrigation is one known strategy for crop growth with compromise on cane yield, however; alternate skip irrigation is relatively better and modern strategy for saving water without compromising on cane yield. The experiment was conducted during 2004 and 2005 at Sugarcane Research Institute Faisalabad, under randomized complete block design with four replications. Conventional irrigation, combinations of both skip irrigation and alternate skip irrigation techniques were made associated with levels of irrigation at 50%, 75% and 100% of total delta of water for sugarcane at the same location employing 120 cm apart deep trenches. Sugarcane variety HSF-240 fertilized with standard NPK doses @ 168:112:112 kg ha^{-1} along with mechanical and chemical weed control by using Gezapax Combi @, 3.75 kg ha^{-1}. Furadon granules @ 35 kg ha^{-1} were applied to control insects. Results revealed that growth parameters were affected and quality traits except cane juice percentage were not affected significantly by different irrigation methods and water levels during the experimental years. Maximum stripped cane yield per hectare was obtained from application of 4000 mm water which was statistically similar to alternate skip irrigation of 3000 mm hence resulted 1000 mm water saving with non-significant compromise on cane and sugar yield.

Keywords: Sugarcane, Irrigation methods, Water Saving.

INTRODUCTION

Pakistan is the 9th biggest grower of sugarcane in the world and because of C_4 growth behavior sugarcane demands bulk of irrigation water failing which poor cane stand, meager cane girth and low cane height, hence, water dearth affected yields negatively (Soares *et al*., 2004). In addition, sugar quality parameters were also influenced badly under water deficit conditions. Pakistan falls in arid to semi-arid regional classification for rain water availability pattern. Scarce canal water and brackish underground water limit the options to irrigate the crop with contentment. Hence, water use efficient strategies are marked as lifeline of the country for agriculture in general and cane production in particular. Irrigation strategies comprising of alternate skip irrigation can help to ensure cane yield in dearth of irrigation water as significant amount of irrigation water can be saved against comparable cane yield.

In sugarcane, tiller or shoot formation and their survival are dominatingly influenced by planting technique, planting time and inter plant competition in addition to soil moisture and ample nutrient supply to the crop plant. Adverse effects of moisture stress are more pronounced for any crop stand establishment such as tiller formation in sugarcane (Rosegrant *et al*., 2009). According to Islam *et al*. (2011) moisture stress caused reduction in internodes per cane. Inter-nodal length is directly proportional to stalk height in cane. Silva *et al*. (2008) stated that inter-nodal length decreased significantly when moisture supply deceased from 15 irrigations to 10 or 5 irrigations through-out the growing period. Inferences showed that stem height in cane was significantly reduced under reduced moisture from field capacity level and at permanent wilting point.

Plant height is quite dependent on water availability in high statured crops like sugarcane and is significantly showed linear relationship under water deficit conditions (Inman-Bamber and Smith, 2005; Soares *et al*., 2004). Cane height was reported more at higher soil moisture level i.e.1.1 IW/CPE than at 0.9 IW/CPE (Pandian *et al*., 1992). Robertson *et al*. (1999) also observed the effect of moderate and severe water stress and reported that plant height was reduced at moderate and severe moisture deficit significantly. Another study established that impact of lesser irrigation towards lesser stem length at the cane maturity stage is sensitive to the availability of moisture level keeping in view other environmental conditions. Very low rate of stem elongation was resulted when observed in respect of cane exposed to moisture deficit conditions (Crépin *et al*., 2012). Hanjra and Qureshi (2010) explored that not only the cane yield increased in response to the increased extent of irrigation but this also enhanced the efficiency of the fertilizer applied. The cane yields were the highest at IW: CPE of 0.9 (18 irrigations) and 1.2 (23 irrigations). Mathew and Kuruvilla (2005) expressed that among the methods of irrigation, furrow irrigation and alternate furrow irrigation had registered comparatively higher values for juice quality parameters like sucrose content, brix, commercial cane sugar (CCS) percent, and purity coefficient with lesser content of reducing sugar and fiber content.

In skip irrigation, if half of the furrows are irrigated and moisture is assumed to reach to the root zone of the neighboring non-irrigated furrows. This affected root growth by attracting them towards the irrigated furrow resulting in irregular root branching and imbalanced plant stand (Chattha, 2007). Alternate skip irrigation is considered an improved strategy in which half of the furrows are irrigated once and rest of the furrows are irrigated in subsequent irrigation hence, supply of water to every sugarcane plant is ensured by irrigating the furrows in alternate fashion and in every event of irrigation which outclassed the short comings of skip irrigation method (Chattha, 2007).

In view of the aforementioned findings, different irrigation strategies were investigated by comparative assessment of irrigation methods for their efficiency and extent of saving water through determining different growth, yield and quality parameters of sugarcane. Confirmation of this hypothesis can be helpful in saving irrigation water.

MATERIALS AND METHODS

The experiment was conducted at Sugarcane Research Institute, Ayub Agriculture Research Institute Faisalabad during 2004 and 2005. The experimental site falls under semiarid region.

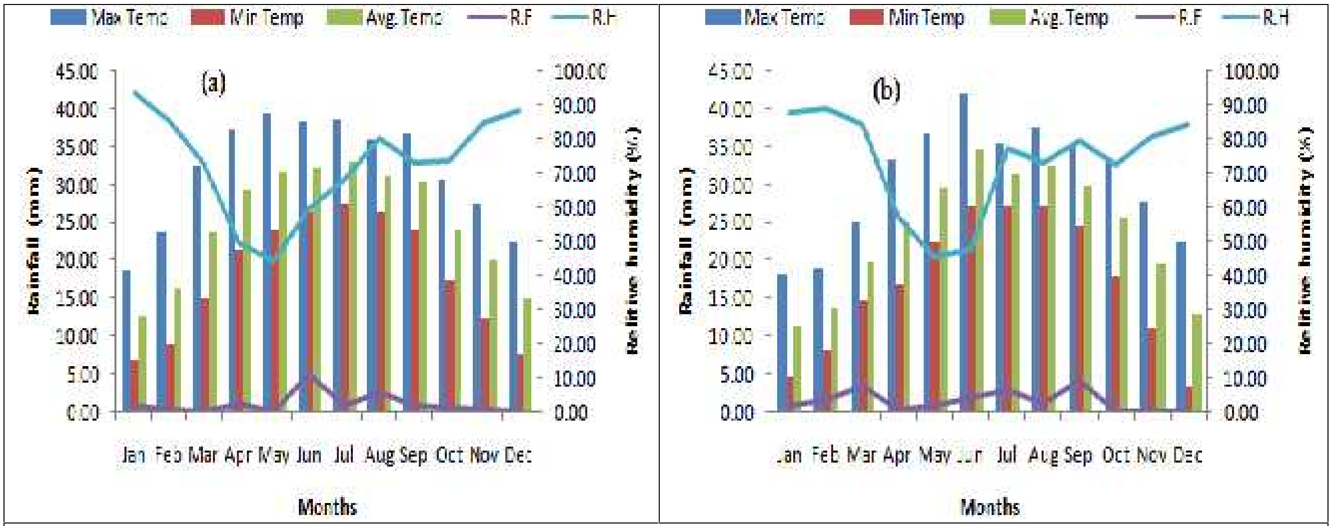

Fig 1: Prevailing climatic conditions of the experimental site during crop growing seasons for the year (a) 2004, and (b) 2005.

The composite soil samples were taken before sowing during the both years and analyzed by using standard procedures and soil analysis is given in table 1.

Table 1: Physico-chemical analysis of the soil.

Soil Characteristics	2004	2005
Sand (%)	30	32
Silt (%)	40	41
Clay (%)	30	27
Ec (dS m^{-1})	1.90	1.89
pH	7.90	8.0
Organic matter (%)	0.95	0.85
Nitrogen (%)	0.053	0.043
Available phosphorus (ppm)	6.90	7.0
Available Potash (ppm)	179	180

Field experiments on sugarcane crop was laid out in randomized complete block design with four replications for consecutive two years duration keeping net plot size 6.5 m × 3.6 m. The experiment was consisted of following treatments, i.e., T_1= Conventional irrigation with 4000 mm water ha^{-1} to all trenches (standard), T_2= Conventional irrigation with 3000 mm water ha^{-1} to all trenches, T_3= Conventional irrigation with 2000 mm water ha^{-1} to all trenches, T_4= Skip irrigation with 3000 mm water ha^{-1}, skipping one trench and watering the other at each irrigation, T_5= Alternate skip irrigation with 3000 mm water ha^{-1}, application of 1^{st} irrigation in one trench leaving next dry and vice versa in 2^{nd} irrigation and henceforth, T_6= Skip irrigation with 2000 mm water ha^{-1}, skipping one trench and watering the other at each irrigation, T_7= Alternate skip irrigation with 2000 mm water ha^{-1}, application of 1^{st} irrigation in one trench leaving the next dry and vice versa in 2^{nd}

irrigation and henceforth. The irrigation water was measured with Syphon and applied according to the treatments for calculated time which is measured with the help of given formula:

$$T\ (\text{Time in seconds}) = \frac{A\ (\text{area to be irrigated } cm^2) \times D\ (\text{Depth of irrigation cm})}{Q\ (\text{Discharge of water } cm^3)} \qquad \text{(Eq.1)}$$

The sugarcane variety HSF-240 was used as medium for trial. The cane sets were used as seed @ 75000 DBS (Double budded setts) ha^{-1}. The crop was planted during spring season on 13th February, 2004 and 15th February, 2005, respectively in the pattern of 120 cm apart deep trenches made with the help of specially designed tractor mounted ridger. Fertilizer was applied @ 168-112-112 NPK kg ha^{-1}. Furadon granules @ 35 kg ha^{-1} were applied to control borers and other insects. Weed control was done by the application of Gezapax Combi @ 3.75 kg ha^{-1} five days after first irrigation with a Knapsac sprayer in addition to manual and mechanical inter-culture using specially designed tractor mounted inter row cultivator. The irrigation water was measured by the use of syphon tubes in rows with equal span of time per row. The crop was harvested manually at its physiological maturity on 23rd December and 24th December during year 2004 and 2005, respectively. At the completion of tillering (after 90 days) total number of plants per unit area was counted. Then total germinant was subtracted from the total plants to get number of tillers per unit area.

Tillers per unit area (ha) = Total number of plants – total number of germinant (Eq.2).

At harvest, internodes of ten randomly selected canes from each treatment were counted and averaged. Length of all internodes of the ten randomly selected canes from each treatment was recorded and averaged. Ten randomly selected stalks from each treatment were tagged for shoot length. Shoot length between soil surface and growing point of shoot was measured at physiological maturity of the crop. Number of millable canes in each plot was counted at harvest and then converted into number of millable canes ha^{-1}. Where, a millable cane refers to the cane that has attained full height and thickness at its physiological maturity and is ready to harvest for processing. At harvest length of ten randomly selected canes from each treatment was measured and averaged. Furthermore, ten canes were randomly selected from each treatment and diameter of each cane from base, middle and top was measured with a Vernier's caliper. Average of these values was taken as cane diameter. A stripped cane refers to the stalk that is clean, free from trash and top, dirt, and other foreign matter. The randomly selected 10 stripped canes from each treatment were weighed together. Then weight per stripped cane (kg) was calculated. All unstripped stalks (stalks along with tops and trash) of each plot were weighed before stripping the trash and removing the tops. The biomass per plot was then converted into the total cane biomass (t ha^{-1}). All millable stripped canes of each plot were weighed together and stripped cane weight per plot was converted into the stripped cane yield (t ha^{-1}). At harvest, the tops of cane shoots of each treatment were removed. The tops of each treatment were weighed separately and converted into tons per hectare (t ha^{-1}). Trash of all stalks from each plot was stripped, weighed and converted into t ha^{-1}. Harvest index (HI) for each treatment was calculated using equation described by Donald and Hamblin (1976) as follows:

$$HI = \frac{\text{Stripped Cane Yield}}{\text{unstripped cane yield}} \qquad \text{(Eq. 3)}$$

Total sugar was calculated as follows:

Total sugar (t ha^{-1}) =

$$\frac{\text{Total stripped cane yield } (t\ ha^{-1}) \times S.R.(\%)}{100} \qquad \text{(Eq. 4)}$$

Where SR% = Percent Sugar recovery

Collected data was analyzed statistically by using Fisher's analysis of variance technique and treatment's means was compared by least significant difference (LSD) at 5% probability level (steel *et al.*, 1997).

RESULTS

Tillers per unit area were significantly affected by different water levels and methods of irrigation application during both years. The conventional irrigation of 4000 mm ha^{-1} water to all trenches resulted in the maximum number of tillers than all other treatments which was followed by alternate skip irrigation method of 3000 mm ha^{-1} water per hectare. Irrigation of 2000 mm ha^{-1} water produced lesser tillers during both years (Table 2).

Internodes per cane were affected significantly by different irrigation methods and water levels during both the experimental years. Significantly higher number of internodes per cane was recorded when 4000 mm water was applied followed by alternate skip irrigation of 3000 mm water (Table 2). Internodal length was significantly affected by different water levels and irrigation methods during both the years. The inter-nodal length was the maximum when 4000 mm water was applied, however, during first year it was statistically at par with alternate skip irrigation of 3000 mm water per ha. Minimum inter-nodal length was recorded in skip irrigation method of 2000 mm. (Table 2). Plant height was significantly affected by different water levels and irrigation methods. During both years, the maximum plant height was achieved at the expense of 4000 mm irrigation water with standard method which was statistically at par with alternate skip irrigation of 3000 mm water. Least plant height was recorded in plants when 2000 mm irrigation water was applied (Table 2). Significant effect of irrigation regimes on millable canes was recorded during both experimental years. Maximum number of millable canes per ha was recorded when standard flooding of 4000 mm was done which was statistically at par with alternate skip irrigation of 3000 mm water. Number of millable canes was the minimum from 2000 mm irrigation (Table 2).

Significant effect of irrigation methods and water levels was found across the years in respect of cane length. Standard flood irrigation of 4000 mm of water produced the maximum cane length and the shortest plant stature was recorded in response to application of 2000 mm water (Table 3). Similarly, cane diameter was significantly affected by different water levels and irrigation methods. During both years, water level of 4000 mm produced maximum cane girth. Minimum cane diameter was recorded from 2000 mm water (Table 3).

Similarly, from Water levels and methods of irrigation application significantly affected the total cane biomass across the growing years .During both years sugarcane cultivation, 4000 mm water level in a conventional method helped to give the maximum total cane biomass which was statistically at par when alternate skip irrigation of 3000 mm water was applied. Minimum total cane biomass was recorded in both skip irrigation of 2000 mm and conventional flooding of 2000 mm (Table 3). Stripped cane yield was significantly affected in both experimental years in response to water levels and methods of irrigation. Standard flooding with 4000 mm of water recorded the maximum stripped cane yield whereas at par results were recorded in alternate skip irrigation of 3000 mm. Consequently, least total cane biomass was recorded in cane plants applied with 2000 mm in a conventional fashion (Table 3). Harvest index of sugarcane was significantly affected by different irrigation methods and water levels and the maximum HI was recorded in plants applied with conventionally flooded 4000 mm water, whereas, the minimum HI was recorded in plants irrigated with 2000 mm irrigation level (Table 3).

Table 2. Effect of different irrigation methods and water levels on yield traits of sugarcane.

Treatments	No. of tillers m^{-2}		Internodal length (cm)		Internodes per cane		Plant height (m)		No. of millable cane ha^{-1}	
	Year I	Year II	Year I	Year II	Year I	Year II	Year I	Year II	Year I	Year II
T$_1$	15.70 ^{a}	16.00 ^{a}	11.60 ^{a}	11.74 ^{a}	19.00 ^{a}	19.03 ^{a}	2.51 ^{a}	2.52 ^{a}	118900 ^{a}	120000 ^{a}
T$_2$	12.88 ^{d}	13.00 ^{d}	10.93^{bcd}	10.91^{bc}	18.68 ^{b}	18.87 ^{b}	2.37 ^{c}	2.39 ^{c}	109100 ^{bc}	110100 ^{bc}
T$_3$	9.91 ^{f}	10.00 ^{f}	10.63 ^{cd}	10.16 ^{cd}	17.28 ^{d}	17.56 ^{d}	2.19 ^{f}	2.21 ^{f}	106500 ^{c}	107500 ^{c}
T$_4$	13.87 ^{c}	14.00 ^{c}	11.11 ^{bc}	11.13 ^{b}	18.87 ^{ab}	18.58 ^{ab}	2.39 ^{b}	2.41 ^{b}	114000 ^{ab}	115000 ^{ab}
T$_5$	15.06 ^{b}	15.20 ^{b}	11.35 ^{ab}	11.15 ^{b}	18.89 ^{a}	18.96 ^{a}	2.50 ^{a}	2.51 ^{a}	118800 ^{a}	120000 ^{a}
T$_6$	11.90 ^{e}	12.01 ^{e}	10.18 ^{e}	10.49 ^{cd}	18.30 ^{bc}	18.51 ^{bc}	2.29 ^{e}	2.31 ^{e}	109000 ^{bc}	110000 ^{bc}
T$_7$	13.13 ^{d}	13.38 ^{d}	10.88 ^{cd}	10.53 ^{cd}	18.40 ^{b}	18.60 ^{c}	2.34 ^{d}	2.36 ^{d}	111500 ^{bc}	112500 ^{bc}
LSD (P ≤0.05)	**0.428**	**0.398**	**0.423**	**0.562**	**0.471**	**0.301**	**0.025**	**0.024**	**6492**	**6543**

Table 3. Effect of different irrigation methods and water levels on yield traits of sugarcane.

Treatments	Cane length(m)		Cane diameter (cm)		Total cane biomass (t ha^{-1})		Stripped cane yield (t ha^{-1})		Harvest Index	
	Year I	**Year II**	**Year I**	**Year II**	**Year I**	**Year II**	**Year I**	**Year II**	**Year I**	**Year II**
T$_1$	2.49 ^{a}	2.52 ^{a}	2.54 ^{a}	2.52 ^{a}	153.0 ^{a}	154.4 ^{a}	106.9 ^{a}	107.8 ^{a}	82.07 ^{a}	82.29 ^{a}
T$_2$	2.36 ^{d}	2.38 ^{d}	2.46 ^{d}	2.45 ^{d}	139.6 ^{b}	140.9 ^{b}	98.2 ^{be}	99.1 ^{be}	78.88 ^{c}	79.28 ^{c}
T$_3$	2.19 ^{f}	2.21 ^{f}	2.32 ^{f}	2.31 ^{f}	123.9 ^{c}	125.0 ^{c}	91.8 ^{e}	92.7 ^{e}	74.47 ^{f}	74.78 ^{g}
T$_4$	2.39 ^{c}	2.41 ^{c}	2.48 ^{c}	2.47 ^{c}	141.3 ^{b}	142.6 ^{b}	100.3 ^{b}	101.2 ^{b}	78.82 ^{c}	78.15 ^{d}
T$_5$	2.44 ^{b}	2.46 ^{b}	2.52 ^{b}	2.50 ^{b}	150.5 ^{a}	151.8 ^{a}	104.9 ^{a}	105.9 ^{a}	80.93 ^{b}	80.99 ^{b}
T$_6$	2.29 ^{e}	2.31 ^{e}	2.42 ^{e}	2.41 ^{e}	126.6 ^{c}	127.7 ^{c}	94.3 ^{d}	95.1 ^{d}	75.58 ^{e}	75.96 ^{f}
T$_7$	2.34 ^{d}	2.36 ^{d}	2.41 ^{e}	2.40 ^{e}	138.5 ^{b}	139.7 ^{b}	97.9 ^{c}	98.8 ^{c}	76.48 ^{d}	76.57 ^{e}
LSD (P ≤0.05)	**0.025**	**0.024**	**0.015**	**0.016**	**3.024**	**3.051**	**2.23**	**2.25**	**0.105**	**0.199**

Various irrigation levels and techniques had significant effect on leaf area per plant, leaf area index, crop growth rate and net assimilation rate (Table 4). The maximum values of leaf area per plant, leaf area index, crop growth rate and net assimilation rate were observed, when sugarcane was supplemented with 4000 mm water to all trenches and these value were at par when water was applied in alternate skip irrigation of 3000 mm water, while, the minimum values of these parameters were recorded with the application of 2000 mm water (Table 4).

Non-significant effect of irrigation methods and water levels was observed in quality traits of sugarcane in respect of brix percentage, pol percentage, cane fiber percent, CCS percentage and sugar recovery percentage whereas, cane juice percentage was influenced by irrigation strategies significantly (Table 5) where alternate skip irrigation of 3000 mm water proved at par with the standard flooding of 4000 mm water to all trenches and can be potential cultivation strategy for the growers to save precious and scarce irrigation water without sacrificing yield.

For total sugar yield, significant effect of water levels and irrigation methods was observed with the maximum total sugar cane yield in conventionally flooded plantation @ 4000 mm water with statistically similar response of alternate skip irrigation @ 3000 mm water. Minimum total sugar yield was recorded in conventionally flooded regime @ 2000 mm water and skip irrigation @ 2000 mm (Table 5).

Table 4. Effect of irrigation methods and water levels on growth parameters of sugarcane.

Treatments	Leaf area per plant		Leaf area index		Average crop growth rate		Average net assimilation rate	
	Year I	Year II	Year I	Year II	Year I	Year II	Year I	Year II
T_1	5901 ^{a}	5954 ^{a}	6. 92 ^{a}	6.98 ^{a}	8.20 ^{a}	8.27 ^{a}	2.07 ^{a}	2.08 ^{a}
T_2	5011 ^{be}	5056 ^{be}	5.51 ^{be}	5.56 ^{be}	7.50 ^{c}	7.57 ^{c}	1.92 ^{c}	1.94 ^{c}
T_3	4184 ^{e}	4222 ^{e}	4.50 ^{f}	4.54 ^{f}	7.06 ^{e}	7.12 ^{e}	1.78 ^{e}	1.79 ^{e}
T_4	5045 ^{b}	5090 ^{b}	4.55 ^{b}	5.60 ^{b}	7.67 ^{b}	7.74 ^{b}	1.96 ^{b}	1.97 ^{b}
T_5	5797 ^{a}	5849 ^{a}	6.88 ^{a}	6.94 ^{a}	8.11 ^{a}	8.18 ^{a}	2.05 ^{a}	2.07 ^{a}
T_6	4583 ^{d}	4624 ^{d}	5.05 ^{d}	5.09 ^{d}	7.22 ^{d}	7.28 ^{d}	1.84 ^{d}	1.86 ^{d}
T_7	4833 ^{c}	4876 ^{c}	5.50 ^{c}	5.53 ^{c}	7.44 ^{c}	7.71 ^{c}	1.90 ^{c}	1.92 ^{c}
LSD ($P \leq 0.05$)	**206.50**	**208.40**	**0.47**	**0.046**	**0.093**	**0.094**	**0.033**	**0.034**

Table 5. Effect of irrigation methods and water levels on quality parameters of sugarcane.

Treatments	**Total sugar yield (t ha^{-1})**		**Brix (%)**		**Pol (%)**		**Cane juice (%)**		**Cane fiber (%)**		**Commercial cane sugar (%)**		**Cane sugar recovery (%)**	
	Year I	Year II	Year I	Year II	Year I	Year II	Year I	Year II	Year I	Year II	Year I	Year II	Year I	Year II
T_1	13.02^{a}	13.74^{a}	20.06	20.00	17.39	17.89	77.50^{a}	78.00^{a}	13.03	13.30	12.96	13.56	12.18	12.74
T_2	12.12^{b}	12.26^{b}	20.25	20.25	17.63	17.64	76.00^{b}	77.00^{b}	13.30	13.03	13.13	13.19	12.35	12.37
T_3	11.15^{c}	11.02^{c}	20.40	20.75	17.68	17.45	74.50^{c}	75.00^{c}	13.60	13.50	12.92	12.66	12.15	11.89
T_4	12.41^{b}	12.45^{b}	20.50	20.50	17.76	17.65	76.00^{b}	77.00 ^{b}	13.03	13.00	13.17	13.09	12.38	12.30
T_5	12.73^{a}	12.96^{a}	20.00	20.25	17.36	17.54	77.00^{a}	77.50^{ab}	13.19	12.90	12.92	13.03	12.14	12.24
T_6	11.52^{c}	11.41^{c}	20.25	21.00	17.53	17.64	74.50^{c}	75.00^{c}	13.66	13.60	13.00	12.77	12.22	11.99
T_7	11.98^{b}	12.05^{b}	20.13	20.75	17.43	17.64	75.00^{c}	75.50^{c}	12.98	12.90	13.00	12.98	12.24	12.20
LSD ($P \leq 0.05$)	**0.30**	**0.80**	**NS**	**NS**	**NS**	**NS**	**0.826**	**0.741**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

T_1 = Conventional irrigation @ 4000 mm ha^{-1}, T_2= Conventional irrigation @ 3000 mm ha^{-1}, T_3= Conventional irrigation @ 2000 mm ha^{-1}, T_4=Skip irrigation @ 3000 mm ha^{-1}, T_5= Alternate skip irrigation @ 3000 mm ha^{-1}, T_6= Skip irrigation @ 2000 mm ha^{-1}, T_7=Alternate skip irrigation @ 2000 mm ha^{-1}

Means sharing the same letter for a single parameter do not differ significantly at $P \leq 0.05$

DISCUSSION

Stumpy water-use efficiency in conventional flooding irrigation employed in most of the Pakistan stressed the need to overcome water scarcity by using highly water use efficient strategies including skip irrigation and alternate skip irrigation (Chattha, 2007). As target in this two years study, quantified irrigation water used for optimum economic production of sugarcane through intervention in its application strategy was soundly idealized in order to ensure improve crop productivity under prevailing as well as upcoming acute water scarce regimes (Pereira *et al*., 2002; Toung *et al*., 2005). Feasibility of such interventions by comparing skip irrigation and alternate skip irrigation strategies through strategy based combinations with irrigation water levels were objectified the quantification of irrigation water saving with obtaining near to optimum cane yield. Such thinking was in line with the strategy of Van Ittersum *et al*. (2003) who discussed the feasibility of crop model to improve crop water productivity in addition to compute the extent of potential of such type of intervention in order to scale down the limitations through edaphic factors or nutrient and water management.

Horikoshi and Fisch (2007) opined that alterations in the rain patterns either in the form of increased or decreased precipitation, left significant impact on water balance of crop plants. However, Santos and Sentelhas (2012) were of the view that such alterations in soil and plant water status due to change in the rainfall patterns and temperature driven evapo-transpiration significantly influenced the consumptive water use of the sugarcane plants. Increased air temperatures under both optimum and reduced rainfall patterns significantly result in greater water deficit for the sugarcane plants resulting into major decline in crop yields (Villani *et al*., 2011).

Alternate skip irrigation strategy has have the potential for improved productivity of sugarcane with meager compromise on cane yields. Kalaisudarson *et al*. (2002) recorded significantly higher attributes with irrigation at IW/CPE ratio of 1.00 than irrigation at IW/CPE of 0.5 with lower values in growth attributes. In 2005, similar trend was observed as in 2004. Similar trend in both the years might be due to similar environmental and soil conditions in both the years. Results were also in agreement across the years showing similar soil and environmental conditions. Results recorded for plant girth was increased productivity of cane in response to strategic water supply at comparatively lower rate were also reported by Hapase (1998). Findings are also in line with those of Kalaisudarson *et al*. (2002) who reported higher growth attributes and yield at higher water ratio 1.00 than 0.5 The results also elucidated the non-significant influence of different irrigation methods and water levels, on the quality attributes of sugar cane, like brix, pol, cane fiber, commercial cane sugar, and sugar recovery percentage, whereas, cane juice percentage was significantly influenced by irrigation strategies. The non significant difference in quality parameters might be due to same variety and similar environmental conditions during both years of experimentation. Conversely, the higher cane juice values were observed when sugarcane was supplied with 4000 mm water, this was due to ample availability of water as compared to the other water application methods and levels. These results are in accordance with previous studies of Mathew and Kuruvilla (2005). They expressed that ample availability of water substantially increased the cane juice percentage as compared to the less availability. The results also revealed an appreciable increase in the total sugar yield, with application of 4000 mm water, however, it was at par with alternate skip irrigation @ 3000 mm water. Moreover, the minimum total sugar yield was recorded in conventional flooding @ 2000 mm water and skip irrigation @ 2000 mm (Table 5). This increase in total sugar yield is attributed to the higher stripped cane yield and more availability of water.

Alternate skip irrigation of 3000 mm water per hectare proved excellent strategy for grower community to achieve the reasonable cane yield with the saving of 1000 mm water. This irrigation strategy proved with similar sugarcane growth, yield and quality as cane applied with conventional flooding method of 4000 mm water.

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