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Evaluation of sugarcane *(Saccharum officinarum* L.) genotypes under variable water regimes

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Abstract

Pre-monsoon period is the most critical phase for irrigation in sugarcane as it coincides with hot and desiccating winds in India. The varieties, which require less water in the summer months are most suitable under moisture stress conditions. The computed water requirement of sugarcane in sub-tropical India requires 140- 180 cm and in tropical India 200-240 cm water throughout the year. Water is the principal limiting factor in sugarcane production. The application of water on desired phase of growth is much important as farmers applying irrigation in the sugarcane on availability of irrigations from the source. There was significant variation among levels of irrigation and different genotypes. Maximum cane yield was obtained at IW/PAN -E (0.8) and found at par with 1.2. Among the early group of genotypes, maximum cane yield was recorded for CoLk 9412 followed by LG 94184 and found significantly superior over CoLk 9414 and CoS 687. Whereas among the mid-late group maximum cane yield was recorded for CoLk 9606 followed by CoLk 9618 and LG 94204 and found significantly superior over CoS 767.

Key words: Critical phase, early & mid-late genotypes, water regimes and IW/PAN-E.

Introduction

The water requirement of sugarcane (*Saccharum officinarum* L.) is normally met by the supplemental irrigation during pre-monsoon period and rain during monsoon months. The pre-monsoon irrigations are crucial importance in relation to tillering and developmental stages. Both scarcity and excessive use of water leads to detrimental effect on growth, tonnage and quality. High yielding varieties perform variably under different water regimes (Phogate *et al.* 1985). At present sugarcane accounts for only 5.1% of irrigation resources of the country. It has been reported that about 35.0% of the total area under sugarcane receives optimum irrigation while remaining 65.0 % comes under sub-optimal and no irrigation category (Bhatnagar *et al.*, 1997). Identification and selection of suitable varieties tolerant to excess and deficient water regimes are important for adoption at farmers level under such prevailing situation. No special emphasis is laid on the selection of sugarcane genotypes/varieties, which would be more responsive to irrigation. Singh and Kanwar (1964) observed that early variety could grow under restricted water supply but mid late needs more water. Majority of workers have concentrated mainly on scheduling irrigation neither through day interval, available soil moisture or plant growth stages. Only limited information is available on scheduling irrigation in this crop based on IW/PAN-E approach that integrates soil-plant-atmospheric continues in a better way. To improve water use efficiency, productivity and quality of sugarcane genotypes, proper scheduling of irrigation plays on important role (Choudhary and Kanwar, 1986). Therefore, this experiment was undertaken to evaluate sugarcane genotypes under variable water regimes during pre-monsoon period of spring planted sugarcane.

Materials and methods

A field experiment was conducted during spring season of 1998-99 and 1999-2000 at the Indian Institute of Sugarcane Research, Lucknow in split plot design with three replications. The treatment comprising of three irrigation regimes (irrigation at IW/PAN-E-0.4 0.8 a 1.2) in main plot and eight genotypes (early group Cos 687, CoLk 9412, CoLk 9414 and LG 94184 and mid-late group CoS 767, CoLk 9606, CoLk 9618 and LG 94204) in sub-plot. The crop was fertilized with 150 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha, respectively. Half dose of nitrogen full dose of phosphorus and potash were applied as basal dressing and out of remaining nitrogen ¼th was applied at tillering and ¼th at maximum grand growth period. Irrigation was based upon IW/PAN-E ratio, where IW refers to depth of irrigation water and PAN-E is the Cumulative Pan Evaporation minus rainfall since previous irrigation. The depth of irrigation was 8 cm. Gravimetric soil moisture content was determined at planting, before and after each irrigation and at harvest. All the agronomic and plant protection operations were carried out uniformly as and when required. The soil of experimental field was sandy loam having 7.54 pH, 261.0 kg/ha available nitrogen, 42.0 kg/ha available phosphorus and 335.0 kg/ha available potassium. The standard procedures were followed for soil chemical analysis. The bulk density of the soil was determined by core sampler method and constant infiltration rate by double ring infiltrometer. The moisture content of top layer (0-30 cm) soil at field capacity and permanent wilting point was 15.17 and 7.3 per cent, bulk density at different depths were 1.34 g/cc (0-15cm) and 1.54 g/cc (15-30cm) and infiltration rate was 0.3 cm/hr, respectively. Five sugarcane plants were taken from each plot for juice analysis. The juice was analyzed for brix (soluble solids) using a Bausch and Lomb refractometer. After clarifying the juice, using lead sub acetate, the pol (juice sucrose concentration) was determined using polarimeter. The percent sucrose in juice was computed using formula developed from sucrose tables and temperature brix correction tables.

Results and discussion

Genotype: Among genotypes, all the growth and developmental characters such as height of the plant, millable canes and commercial cane sugar were higher in mid late group as compared to early group of genotypes. Among mid late group of genotype higher yield attributes were recorded in CoLK 9618 and CoLK 9606 as compared to CoS 767, where as among early groups of genotypes, maximum yield attributing characters were recorded in CoLK 9412 followed by CoLK 9414 and found significantly superior over CoS 687. Singh *et al.* (1998) also reported variation in cane yield in different genotypes of sugarcane due to yield attributing characters. Quality parameters such as brix (%), pol (%), purity (%) and sugar recovery (%) was higher in mid late groups as compared to early group of genotypes. During first year, these characters were found significantly superior over each other but during second year the variations were non-significant. The interaction effects among irrigation and genotypes did not reached to the level of significance (Table 1 & 2).

Cane yield: Results revealed that there was significant variation among levels of irrigation. Maximum cane yield was obtained at IW/PAN-E (0.8) and found at par with 1.2, whereas and minimum was recorded at 0.4 during both the years of experimentation. The increase in cane yield in both the treatments over IW/PAN-E (0.4) was to the tune of 8.25 and 7.40% during first year and 6.04 and 5.25% during second year, respectively. The results are in the conformity of Singh and Kanwar (1964). There was significant variation among genotypes at different levels of irrigation. Among early group, maximum cane yield was recorded in CoLK 9412 followed by LG 94184 and found significantly superior over CoLK 9414 and CoS 687. The increase in cane yield of CoLK 9412, LG 94184 and CoLK 9414 over CoS 687 was 102.9 and 96.1 and 44.1% during first year and 142.9 and 115.4% and 75.8% during second year, respectively. Similar result was reported by Choudhary and Kanwar (1986). Among, mid-late group, maximum cane yield was recorded in CoLk 9606 followed by CoLK 9618 and LG 94204 and found significantly superior over CoS 767 and increased yield was 48.6, 42.7 and 27.7% during first year and 51.6, 47.0, and 19.7% respectively. The interaction effects of levels of irrigation and genotypes were also significant. All the genotypes of early group recorded maximum cane yield at IW/PAN-E ratio of 0.8, whereas in mid-late group, maximum cane yield was recorded at IW/PAN-E at 1.2, respectively. Minimum cane yield of all the genotypes were at IW/PAN- E ratio of 0.4. WUE was higher at IW/PAN-E ratio of 0.4 followed by preceding higher levels (Table 1).

The effects of levels of irrigation on plant height and millable cane were significant. Maximum height of the plant and commercial cane sugar (CCS) was recorded at higher levels of irrigation, whereas maximum millable cane was recorded at IW/PAN-E ratio of 0.8. The interaction effects in all the characters were also significant.

Water use and water use efficiency: Total water use was computed as the sum of irrigation water, effective rainfall and profile water depletion to a depth of 90 cm. Water use efficiency (WUE) was calculated as the quantity of produce per unit of water used. Water use increased in increase in number of irrigation. Total water use and amount of irrigation during first & second year of experimentation (168 & 171.0 cm) was higher in case of IW/PAN-E ratio (1.2) followed by preceding levels of irrigation (IW/PAN-E ratio 0.8 and 0.4). The results are in the conformity of results of Singh et al. (2001). It might be due to greater leaf area and higher dry atter production. Higher rate of water use per day was recorded in IW/PAN-E ratio (1.2), while the lowest rate was observed in IW/PAN-E ratio 0.8 & 0.4), respectively.

WUE was influenced by the seasonal rainfall and number of irrigation applied. Water use efficiency was lower in higher irrigation regimes (IW/PAN-E-1.2). Highest WUE was observed in IW/PAN-E ratio 0.4 and 0.8 treatments in which lesser number of irrigations was applied. Similar results are reported by Singh *et al.* (1997). It is interesting to note that WUE was more in mid-late group of genotype as compared to early groups. Among mid late groups, maximum WUE was recorded in CoLk 9606 and CoLk 9616, whereas among early groups, WUE was more in CoLk 9412 and LG 94184, respectively (Table 1).

Juice quality: Brix, Pol (%) in juice, purity (%) and sugar recovery (%) were not affected due to different levels of irrigation. However, all the quality parameters responded to higher level of irrigation. Maximum sugar yield was observed in IW/PAN-E ratio of 1.2 and minimum at preceding lower levels but could not reach to the level of significance. It is evident from the results presented in Table 2 that early group of genotype produced more sugar yield as compared to mid late groups and found at par. Singh *et al.* (2001) also observed the similar results. Among genotypes, sugar recovery was maximum in early groups as compared to mid-late and found significantly superior over each other. Among early groups, maximum sugar recovery was recorded in CoLk 9414 (11.14& 11.77%) and LG 94184 (11.12 & 11.75%) followed by CoLk 9412 (10.99% & 11.59%) and CoS 687 (10.83% & 11.35%), respectively. However, among mid-late groups, maximum sugar recovery was recorded infor CoS 767 (10.96 & 11.64%) followed by CoLk 9606 (10.06 & 11.49%), CoLk 9618 (9.64 & 11.32%) and LG 94204 (9.17 & 11.17%), respectively during first and second year of experimentation. It is evident from the table that during first year, there was variation in sugar recovery among the genotypes and found significantly superior, where as during second year of experimentation levels of irrigation had significant impact.

Table 1. Effect of levels of irrigation on growth and developmental characters of different genotypes of sugarcane (1998-99 and 1999-2000).

Treatments	Height (m)		Millable cane (th/ha)		Cane yield (t/ha)		Water used (cm)		WUE (t/ha/cm)	
	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000
Irrigation										
I_1 (0.4)	1.82	1.74	105.22	108.48	64.08	57.34	142	147	0.44	0.39
I_2 (0.8)	1.90	1.86	112.63	114.40	69.37	59.60	155	160	0.43	0.37
I_3 (1.2)	1.97	1.89	108.23	113.95	68.83	60.29	168	171	0.40	0.35
Genotypes (Early)										
CoS 687	1.24	1.36	87.78	75.97	36.86	28.40	155	162	0.24	0.17
Colk 9412	2.09	1.76	112.19	110.46	74.81	61.17	155	162	0.48	0.37
Colk 9414	1.62	1.63	120.47	109.94	53.21	49.93	155	162	0.34	0.30
LG 94184	1.96	1.91	124.67	133.13	72.28	69.00	155	162	0.46	0.42
Mid-late										
CoS 767	1.82	1.84	96.64	104.69	58.26	50.96	160	167	0.34	0.30
Colk 9606	2.15	2.04	106.30	120.95	86.58	77.22	160	167	0.54	0.46
Colk 9618	2.02	2.05	112.67	121.37	83.14	74.94	160	167	0.51	0.44
LG 94204	2.27	2.06	108.84	111.68	74.37	60.99	160	167	0.46	0.36
C.D. for Irrigation 5% (I)	0.04	0.08	1.46	1.38	2.00	N.S.	-	-	-	-
C.D. for genotypes 5% (G)	0.07	0.04	1.77	4.90	2.55	3.03	-	-	-	-
C.D. for Interaction 5% (I x G)	0.12	0.10	3.07	5.65	3.12	4.04	-	-	-	-

Changes in soil physical and chemical parameters: It is evident from the Table 3 that at harvest, there was deviation in physical parameters from initial status of the soil. The soil moisture at the harvest of the crop at different depths were 9.79% (0-15cm) and 11.99% (15-30cm) in IW/PAN-E (0.4), 10.42% (0-15) and 11.46% (15-30cm) in IW/PAN-E (0.8) and 12.94% (0-15cm) and 13.91% (15-30cm) in IW/PAN-E (1.2), respectively. The bulk density were 1.42, 1.52 and 1.48gm/cc at 0-15cm, 1.54, 1.57 and 1.54 gm/cc at 15-30cm in IW/PAN-E ratio of 0.4, 0.8 and 1.2 levels of irrigation were observed, it indicated that there was slight variation in moisture percentage but increase in bulk density is due to application of different quantity of water. There was no change in infiltration rate due to variable water regimes.

Table 2. Effect of levels of irrigation on quality characters of different genotypes of sugarcane (1998-99 and 1999-2000).

Treatments	C.C.S. (t/ha)		Brix (%)		Pol (%)		Purity (%)		Sugar Recovery (%)	
	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000
Irrigation										
I_1 (0.4)	6.72	6.62	18.35	18.98	16.70	19.02	85.50	90.56	10.56	11.58
I_2 (0.8)	7.02	6.76	17.73	19.45	16.82	18.71	85.30	91.04	10.34	11.28
I_3 (1.2)	7.13	7.17	18.39	19.50	16.95	19.23	87.40	89.92	10.58	11.68
Genotypes (Early)										
CoS 687	3.80	3.31	19.10	19.61	18.06	18.85	86.49	87.44	10.83	11.35
Colk 9412	8.22	7.18	18.82	19.82	17.46	18.99	86.23	90.33	10.99	11.75
Colk 9414	5.89	5.78	19.31	19.78	18.49	19.72	88.10	90.78	11.12	11.59
LG 94184	8.04	8.11	20.07	19.48	18.56	19.26	83.88	91.44	11.14	11.77

Mid-late										
CoS 767	6.30	6.21	18.37	19.81	17.18	18.48	87.70	91.11	10.96	11.64
Colk 9606	8.67	8.99	16.92	18.96	15.64	18.65	86.94	92.56	10.06	11.49
Colk 9618	7.91	8.34	16.20	18.12	14.88	19.19	86.37	91.44	9.64	11.32
LG 94204	6.81	6.84	16.47	18.89	14.33	18.77	82.33	88.67	9.17	11.17
C.D. for Irrigation 5% (I)	N.S.	N.S.	0.61	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.28
C.D. for genotypes 5% (G)	0.56	1.21	0.99	N.S.	0.74	N.S.	2.80	N.S.	0.69	N.S.
C.D. for Interaction 5% (I x G)	0.97	N.S.	N.S.	N.S.	N.S.	1.53	N.S.	N.S.	N.S.	N.S.

Table 3 - Soil physical and chemical properties of experimental site.

Treat-ments	Depth (cm)	Initial bulk density (gm/cc)	Final bulk density (gm/cc)	Initial moisture (%)	Final Moisture (%)	Infil-tration rate (cm)	pH	Nutrient status (kg/ha)		
								N	P	K
I_1	0-15	1.34	1.42	15.16	9.79	0.3	7.45	267	42	335
	15-30	1.54	1.54	15.18	11.99					
I_2	0-15	1.34	1.52	15.16	10.42	0.3				
	15-30	1.54	1.57	15.18	11.46			(Low)	(Medium)	(Medium-High)
I_3	0-15	1.34	1.48	15.16	12.94	0.3				
	15-30	1.54	1.54	15.18	13.91					

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References

Bhatnagar V.K., Singh R.D., Dey P. and Singh P.N. 1997. Efficient water anagement in Sugarcane production for increasing sugar recovery, Proc. National Symposium on Sugar recovery: Problem and Prospects, September, 13-15 pp. 27- 29.

Choudhary O.S. and Kanwar R.S. 1986. Irrigation requirement of different varieties of sugarcane. *Indian J. Sugarcane Research*, **13**:12-14.

Phogat B.S., Singh V.R., Verma, S.S. and Verma R.S. 1985. Studies on the water requirement of different varieties of sugarcane. Proc. National Symposium of Cropping System, April, 3-5, pp.63.

Singh J.R.P., Sinha U.P. and Kumar, S. 1998. Performance of mid late sugarcane varieties of north central zone in calcareous soil of north Bihar. *Indian sugar*, **49**:411-414.

Singh, P.N., Singh Mohan and Dey, P. 1997. Irrigation scheduling and nitrogen application to water use, yield and quality of sugarcane. *Indian J Sugarcane Technol.*, 12:46-51.

Singh P.N., Dey Pradip, Bhatnagar, V.K. and Singh R.D. 2001. Effect of press mud, FYM and irrigation regimes on water use, yield and quality of Sugarcane. *Indian J Sugarcane Technol.*, 12:46-51.

Singh S. and Kanwa R.S. 1964. Studies on the yield behavior of some cane varieties in Punjab under optimum and restricted water supply. *Indian Sugar*, 14:142-148.