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Effect of moisture conservation practices on growth and yield of sugarcane (*Saccharum officinarum* L.) under different irrigation regimes

Rajesh Singh and RK Singh

Abstract
The field experiment was carried out during 2015-16 to 2016-17 at Agriculture Research Farm of Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, to study the effect of irrigation regimes and moisture conservation practices on growth yield and quality of sugarcane (*Saccharum officinarum* L.). The experiment was laid out in strip plot design with combinations of 3 irrigation regimes [irrigation at 0.5, 0.75 and 1.0 irrigation water: cumulative pan evaporation (IW: CPE)] in horizontal-strip plot and 6 moisture conservation practices [control, trash mulch, silicon @0.5%, kaolin @ 0.8%, trash mulch + silicon @ 0.5% and trash mulch + kaolin @ 0.8%] in vertical strip plot along with 3 replication. The results indicated that significantly maximum plant heights (17.19% & 16.48%), cane length (16.43% & 15.60%), number of millable cane (13.52% & 13.49%) and total cane biomass (21.34% & 20.55%) were recorded with application of irrigation regimes at 1.0 IW: CPE ratio compare to irrigation regimes at 0.50 IW: CPE respectively, while it was found statically at par with irrigation regimes at 0.75 IW:CPE in both the years. Furthermore the moisture conservation practice with trash mulch + silicon @ 0.5% was recorded significantly higher value over other treatments. Moreover, the moisture conservation practice with Trash mulch + kaolin @ 0.8% found at par with silicon @0.5%, trash mulch and kaolin @ 0.8% in both the year, respectively.

Keywords: Sugarcane, irrigation, trash mulch, silicon, kaolin, growth and yield

Introduction

Sugarcane is the most important cash crops of India grown under various agro meteorological conditions ranging from tropical to subtropical climate. Important sugarcane producing countries in the world are Brazil, India, China, Thailand, Pakistan, Cuba and Mexico, in which India has second position in both area and production after Brazil. In India, area and production of sugarcane has been fluctuating from year to year depending upon price policy and climatic conditions. It is a C_4 plant therefore, able to convert up to 2 per cent of incident solar energy in to biomass. There is a direct relationship between the growth rate and optimum soil moisture because vegetative growth is only considered as economic yield (Singh and Mohan, 1994). Sugarcane is a long duration crop resulted high water requirement than other crops because of long tillering phase during months of summer when there is higher evaporative demands. Formative phase of the crop, in which the crop requires more water to maintain tenderness, along with hot and desiccating summer, therefore, plenty soil moisture is required to get better growth and maximum economic yields. Efficient utilization of available water resources is vital for a country like India, which contribute 17 per cent of the global population with only 2.4 per cent of land and 4 per cent of the world'^s water resources. The per capita per year availability, in relation to average utilizable water resources is 1250 m^3, which was 6,008 m^3 in 1947 and is expected to drop off to 760 m^3 by the year 2050. Agriculture sector becoming the largest consumer of water, because, to meet the food security, income and nutritional needs of the growing population in India will have require almost double production. With increasing demands on limited water recourses needs judicious management of irrigation. The water requirement of sugarcane is normally met through supplemental irrigation during pre-monsoon period and rain during monsoon. It has been reported that about 35.0% of the total area of sugarcane comes under optimum irrigation while remaining 65.0 % comes under sub-optimal and no irrigation category (Bhatnagar *et al.*, 2007) [1, 11]. In tropical India, the number of irrigations range from 30 to 36; while in the subtropics 5 to 10 irrigations are required with a depth of 60 mm. The water requirement of sugarcane in India varies widely from 1,143 to 3,048 mm (Hapase *et al*., 1990) [6]. Scientists have worked to improve irrigation water-use efficiency 1.5–2.5 times through adopting advance irrigation techniques and practices. To get maximum yield of sugarcane are required to maintaining very high moisture in entire rhizosphere during the whole growing season, until about 1 month before harvesting. Therefore, irrigation scheduling based on climatological approach is need of the present time for increasing water use efficiency in sugarcane. Irrigation scheduling based on pan evaporation reduces the irrigation requirement without any adverse effect on the yields. The major benefit of this approach is that farmers not require changing the amount of water applied from one irrigation to another and the event of rain also taking care off. Irrigation based on this approach permits the calculation of a timetable for the irrigation, provided the pattern of pan evaporation does not show much yearly variation during the growing period (Singh *et al*., 2007) [1, 12]. Along with irrigation scheduling IW: CPE ratio moisture conservation practices such as mulching, kaolin and silicon as an antitranspirants play crucial role in improving water use efficiency. Silicon is a beneficial element for plant growth and play also vital role in stressed condition. When Si becomes deficient in soils, there is evidence from a number of studies that the rate of transpiration increases. Okuda and Takahashi (1965) reported that the rate of transpiration of Si-deficient barley increased by about 10% over the control plants. Similarly, Gong *et al*., (2003 and 2005) [4, 5] also observed improved water economy and dry matter yield of wheat under application of silicon. Thakuria *et al.* (2004) [15] observed that application of kaolin reduce the transpiration losses of water due to reflection of solar radiation incident on leaf surface, result maintain the available soil moisture over longer period. Similarly mulch also maintain moisture status into the soil by avoiding direct contact of solar radiation, wind waves with soil and by reducing evaporation, runoff and weeds population. Keeping these in view, the present field experiment was conducted to optimize irrigation schedule in sugarcane with different moisture conservation practices.

Materials and methods

A field experiment was carried out at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh), during 2015–16 to 2016–17. The experiment was laid in quite uniform topography and well-drained soil which had homogenous status. Geographically, experimental site came under the sub-tropical zone of Indo-Gangatic plains. It is located on $25^0$20' N latitude, $83^0$4' E longitude and at an altitude of 76.60 meters above mean sea level in the Northern Gangatic alluvial plains. The soil of the experimental field was sandy clay loam in texture. The experiment was laid out in strip plot design with combinations of 3 irrigation regimes [irrigation at 0.5, 0.75 and 1.0 irrigation water: cumulative pan evaporation (IW: CPE)] in horizontal-strip plot and 6 moisture conservation practices [control, trash mulch, silicon @0.5%, kaolin @ 0.8%, trash mulch + silicon @ 0.5% and trash mulch + kaolin @ 0.8%] in vertical strip-plot. 150 kg N, 80 kg P_2O_5, 60 K_2O kg ha^{-1} were applied by the source of urea, DAP and MOP, full dose of phosphorus, potash and half dose of nitrogen applied as basal dose and remaining half dose of nitrogen applied in two equal split as top dressing. To calculate applied irrigation water, Parshall flume installed at start of water channel and time was recorded to fill the experimental plots to the pre decided levels. Total water applied during entire crop growing season was calculated by adding the depth of water delivered into plot and number of irrigation applied. Five millable cane were selected randomly from each treatment unit and used for recording number of internodes, internode length (cm), plant height (m), millable cane length (m) and cane diameter (cm). Number of millable cane was calculated by selecting one square meter area in each treatment plot randomly and count millable cane.

Table1. Effect of irrigation regimes and moisture conservation practices on Number of internodes per cane, Internode length, Plant height, Number of millable cane, Cane length and Cane diameter at harvest:

Treatments	Number of internodes per cane		Internode length (cm)		Plant height (m)		Number of millable cane (m^{-2})		Cane length (m)		Cane diameter (cm)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Irrigation regimes												
I_1 (0.50IW: CPE)	19.68	19.90	12.21	12.20	3.71	3.80	9.72	9.81	2.34	2.38	2.58	2.60
I_2 (0.75IW: CPE)	20.81	20.83	13.04	12.84	4.24	4.34	10.86	10.87	2.69	2.77	2.70	2.71
I_3 (1.0 IW: CPE)	21.26	21.36	13.18	13.23	4.48	4.55	11.24	11.34	2.80	2.82	2.71	2.72
SEm±	0.48	0.49	0.23	0.27	0.09	0.08	0.22	0.23	0.07	0.06	0.05	0.05
CD (p=o.o5)	NS	NS	NS	NS	0.32	0.30	0.87	0.88	0.28	0.22	NS	NS
Moisture conservation practices												
M_0 (Control)	19.80	20.16	12.17	12.38	3.59	3.77	9.62	9.68	2.23	2.35	2.52	2.55
M_1(TrashMulch)	20.65	20.67	12.71	12.75	4.10	4.18	10.50	10.59	2.62	2.63	2.67	2.68
M_2 (Silicon)	21.03	20.85	12.96	12.90	4.18	4.27	10.60	10.67	2.66	2.71	2.70	2.71
M_3(Kaolin)	20.22	20.25	12.65	12.44	3.99	4.13	10.50	10.57	2.51	2.57	2.63	2.65
M_4 (Trash mulch + Silicon)	21.17	21.45	13.22	13.17	4.76	4.77	11.60	11.68	2.94	2.95	2.76	2.77
M_5 (Trash mulch + Kaolin)	20.65	20.80	13.14	12.91	4.23	4.26	10.82	10.86	2.70	2.74	2.70	2.72
SEm±	0.44	0.45	0.27	0.26	0.09	0.09	0.22	0.23	0.07	0.05	0.05	0.07
CD (p=o.o5)	NS	NS	NS	NS	0.27	0.28	0.69	0.70	0.23	0.17	NS	NS

Results and discussion

Irrigation Schedules

The data present in Table 1 indicated that the different irrigation regime significant improves the growth and yield attributes of sugarcane in both the years. The maximum Plant height (4.48 & 4.55 m), cane length (2.80 & 2.82 m) and number of millable cane (11.24 & 11.34), were found significantly superior with irrigation schedules at 1.0 IW: CPE compare to 0.50 IW: CPE, while it was at par with irrigation schedules at 0.75 IW: CPE in both the years respectively. Similarly, fig-1 show the total biomass (151.94 & 153.71 t ha^{-1}) of sugarcane recorded significantly higher with the irrigation regime 1.0 IW: CPE ratio over 0.50 IW: CPE while at par with irrigation schedules at 0.75 IW: CPE in both the years respectively. Furthermore the irrigation schedules were found non-significant effect on number of internodes per cane, internode length and cane diameter in both year of experiment. This was because better physiological processes due to frequent watering which improved microclimate and uptake of dissolved nutrients. Water act as a solvent for plant nutrients, plant can absorbed nutrients when these nutrients are dissolved in water. Singh *et al.* (2015) [13]. Similar result was observed by Singh *et al.* (2015) [13] Kumawat *et al*. (2010) [8]; Shomeili *et al.* (2013) [11] .

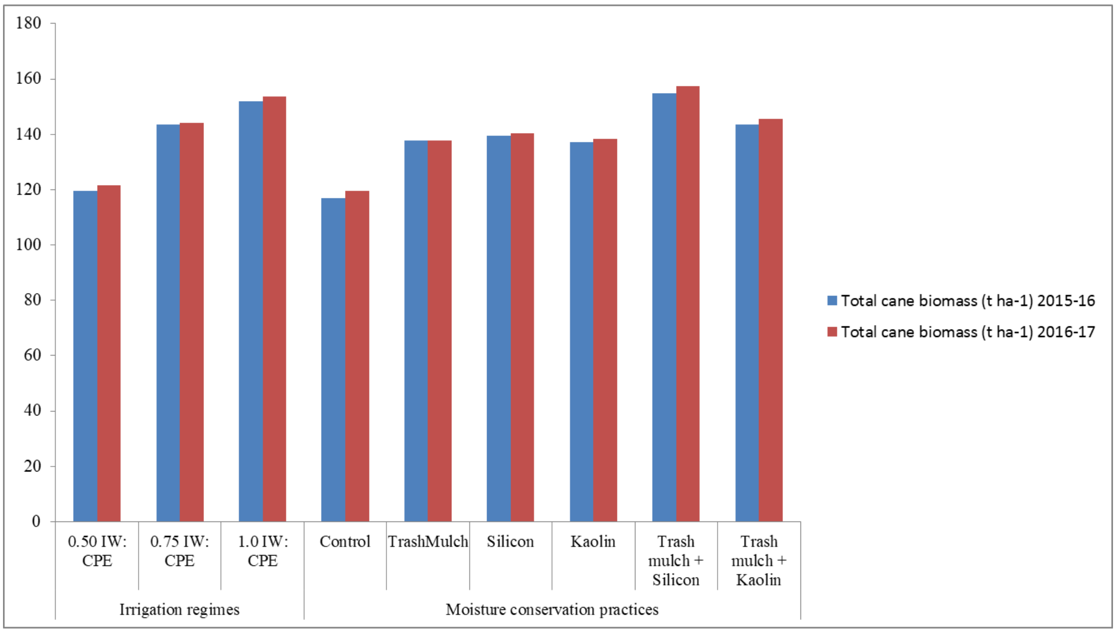

Fig 1: Effect of irrigation regimes and moisture conservation practices on total cane biomass of sugarcane at harvest

Moisture conservation practices

The data present in the table 1 shows that the significantly higher value of plant height (4.76 & 4.77 m), cane length (2.94 & 2.95 m) and number of millable cane (11.60 & 11.68) were recorded under trash mulch + silicon @ 0.5% over all other treatments in both the years. Furthermore, the application of trash mulch + kaolin @ 0.8% found significantly at par with treatment silicon @0.5%, trash mulch, kaolin @ 0.8%, in both the years respectively. Similarly, fig-1 presented that the total biomass (154.96 & 157.31 t ha^{-1}) of sugarcane observed significantly higher under trash mulch + silicon @ 0.5% over all other treatments in both the years. Moreover, the application of trash mulch + kaolin @ 0.8% found significantly at par with treatment silicon @0.5%, kaolin @ 0.8% and trash mulch, in both the years respectively. The moisture conservation practices did not significant effect on number of internode per cane, internode length and cane diameter in both years. The minimum value of plant height, number of millable cane, cane length and total biomass of sugarcane were observed in control. Silicon maintained water status of plants by reducing transpiration without affecting photosynthesis results enlargement of cell due to turgor pressure and cell division which ultimately increase the growth of plant and yield attributes, Hattori *et al.* (2005) [7]. Trash mulch maintain soil water status by reducing evaporation, runoff and weeds which ensure adequate supply of moisture result increased growth and yield attributes, Mishra (1996) [9]. Similar result was found by Camargo *et al.* (2017) [2]; Chitodkar *et al.* (2006) [3].

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