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Management of sugarcane (*Saccharum officinarum*) under moisture-stress conditions of Tungabhadra project area

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ABSTRACT

A field experiment was conducted during 1989, 1990 and 1991 to develop a suitable cultural practice for sugarcane (*Saccharum officinarum* L.) grown under moisture stress. Soil application of extra K @ 40 kg/ha before last irrigation with or without mulch was found beneficial and gave higher cane and sugar yield. Urea and K spray combinations were found second best to overcome the early loss of growth due to moisture stress. Soil or foliar application of K helped retain better quality parameters.

Sugarcane (*Saccharum officinarum* L.) experiences moisture stress during May—July due to canal closure. Sugarcane being the second most important crop of command area after rice, is grown largely as a annual crop. This cropping method invariably experiences drought during summer. In addition, as the grand-growth period conincides with the canal lean period, the crop is subjected to moisture stress causing severe reduction in the yield (Koehler *et al.*, 1982). Information on evading moisture stress through various agronomic practices are limited. Therefore the present investigation was aimed to evolve a suitable technology to evade moisture stress.

MATERIALS AND METHODS

A field experiment was caried out during 1989, 1990 and 1991 at the Agricultural Research Station, Gangavati, on a Vertisol. Soil had pH 8.1 with an electrical conductivity of 1.6 dS/m. The cation-exchange capacity was high (60.6 c mol/kg) and low to medium organic carbon content (0.2—0.45%). The soil had low available N (135.6 kg/ha), medium level of P (16.3 kg/ha) and higher level of K (375.4 kg/ha). Soil is nearly calcareous (12.5%), with soil solution pre-dominated by basic cations,

Table 1. Effect of cultural practices on cane yield, sugar yield and sugar recovery (pooled mean of 1989, 1990 and 1991)

Treatment	Cane yield (tonnes/ha)	Sugar yield (tonnes/ha)	Sugar recovery (%)
T_1	99.30	9.92	8.82
T_2	101.26	10.86	9.13
T_3	110.06	12.44	10.21
T_4	115.18	12.68	10.55
T_5	58.67	5.24	8.67
T_6	119.85	12.69	10.53
T_7	79.15	8.64	9.72
CD (P = 0.05)	5.93	2.06	0.77

Treatment details are given in text

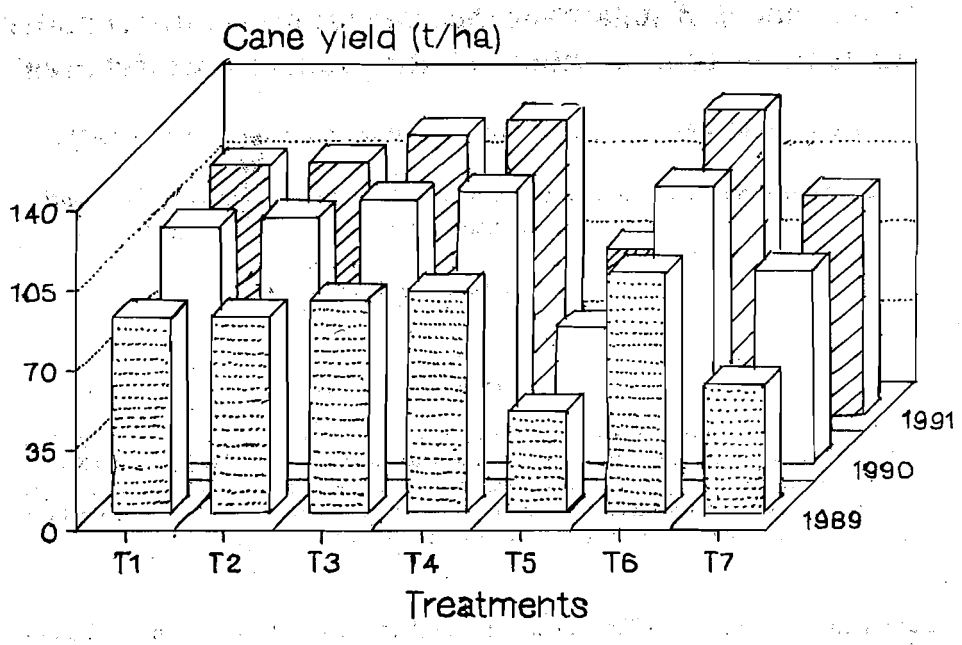

Fig. 1. Effect of cultural practices on cane yield (1989, 1990 and 1991)

especially Na. The experiment was planned with 7 treatment combinations suited to randomized block design, involving 3 replications. Treatments were, viz. T_1, spraying with 2.5% K_2O through muriate of potash (MOP) and 2.5% N through urea at 30 and 60 days after planting; T_2, spraying with 2.5% K_2O (MOP) and 2.5% N (urea) at 60 and 90 days after planting; T_3, application of extra K @ 40 kg/ha before last irrigation; T_4, T_3 + mulching (trash @ 5 tonnes/ha); T_5, cutting the crop at base 15 days after last irrigation, i.e. encouraged as ratoon; T_6, protective irrigation during summer (check); and T_7 no irrigation during summer (control)

The planting was initiated during second fortnight of January with 'CoC 671' as the test variety. Selection was done on the basis of area of coverage in the Tungabhadra project command. During the study period, canal supplies were terminated between first week of May and last week of July. During canal supply, the sugarcane crop was irrigated once in every 15 days as per the recommendation for medium-black soils of Karnataka. Rainfall received during lean period was 101.2, 257.9 and 216.8 mm with 5, 18 and 15 rainy days during 1989, 1990 and 1991 respectively.

RESULTS AND DISCUSSION

In general, all the parameters of sugarcane computed improved in different years (Table 1). This increasing trend was primarily owing to corresponding higher rainfall received.

Cane yield

On the basis of data available over years, cane yield was largely influenced by various treatments (Fig. 1). A highest mean cane yield was recorded in treatment receiving protective irrigation during summer (Table

Table 2. Effect of cultural practices on yield-attributing parameters of sugarcane

Treatment	1989			1990			1991		
	Cane length (m)	Cane girth (cm)	Cane weight (kg)	Cane length (m)	Cane girth (cm)	Cane weight (kg)	Cane length (m)	Cane girth (cm)	Cane weight (kg)
T_1	1.78	2.65	0.91	1.52	2.46	0.77	1.72	2.42	0.95
T_2	1.63	2.58	0.80	1.45	2.41	0.80	1.82	2.46	1.01
T_3	1.90	2.85	1.03	1.83	2.85	1.07	1.96	2.86	1.00
T_4	2.07	2.91	0.92	1.97	2.88	1.19	2.08	2.89	0.98
T_5	0.90	2.10	0.57	1.15	2.04	0.60	1.13	1.99	0.81
T_6	2.17	2.98	1.48	2.17	3.03	1.30	2.09	2.96	1.20
T_7	1.50	2.67	0.66	1.31	2.43	0.65	1.35	2.43	0.80
CD (P = 0.05)	0.17	0.25	0.19	0.19	0.12	0.18	0.29	0.31	NS

Treatment details are given in text

1). The crop under natural existing stress (control) yielded 79.15 tonnes/ha over years (Table 1), indicating a mean reduction of 33.96%. Amongst other treatments, a lowest yield was obtained in case where the crop was cut to encourage ratooning. This was included to encourage lower biomass and evapo-transpiration during moisture stress.

Application of K induces drought tolerance by maintaining cell turgidity and better transport of carbohydrates. Spraying of crop with 2.5% K (MOP) and 2.5% N (urea) at 30 and 60 days and 60 and 90 days resulted in significantly higher cane yield over the control. However, foliar sprays at different periods remained at par, indicating effectiveness of both in increasing cane yield (Table 1). The increased cane yield over the control was owing to higher values of yield attributes (Table 2). These findings confirm those of Manoharan *et al.* (1992). Soil application of extra K @ 40 kg/ha before the last irrigation with or without mulch recorded significantly higher cane yield over others except those receiving protective irrigation (Fig. 1), and a mean reduction of 3.9 and 8.2% were observed. The difference between treatments receiving 40 kg extra K along with mulching (115.18 kg/ha) and only 40 kg extra K (110.06 kg/ha) before last irrigation were non-significant. Higher cane length, girth and weight were observed in these compared with other treatments except check (Table 2). Results are in agreement with Saxena (1989) and Yadava (1991). Muching of crop enhanced yield potential of the crop due to favourable microclimate (Singh *et al.*, 1984).

Correlation between yield (Y) and cane length [x_1], girth [x_2] and weight [x_3] were found significant (Table 4), and were regressed further to yield following relationships :

1989

$$Y = 48.8367 + 93.5627\ x_1 - 47.8127\ x_2 - 1.6743\ x_3 \quad (R^2 = 98.17)^*$$

1990

$$Y = 75.0985 + 11.7383\ x_1 - 73.1905\ x_2 - 33.13\ x_3 \quad (R^2 = 82.70)^*$$

1991

$$Y = 30.184 + 2.7503\ x_1 + 23.9307\ x_2 - 11.9124\ x_3 \quad (R^2 = 96.11)^*$$

Pooled

$$Y = 7.8926 + 21.4564\ x_1 + 5.6062\ x_2 + 2.5199\ x_3$$

Table 3. Effect of cultural practices on quality parameters of cane

Treatment	1989				1990				1991			
	Brix (%)	Pol (%) juice	Purity (%)	CCS (%)	Brix (%)	Pol (%) juice	Purity (%)	CCS (%)	Brix (%)	Pol (%) juice	Purity (%)	CCS (%)
T_1	18.15	15.03	82.81	11.66	21.70	18.82	86.72	12.90	23.20	21.41	92.28	15.11
T_2	20.50	17.17	86.20	13.46	22.30	19.11	85.70	13.02	23.74	22.45	90.78	15.72
T_3	21.75	18.77	86.30	12.83	23.80	21.35	89.71	14.87	24.26	22.68	93.49	16.10
T_4	22.30	17.27	77.45	11.41	23.90	21.09	88.23	14.58	24.60	22.47	91.34	15.78
T_5	17.63	14.03	79.58	9.19	20.00	16.00	80.01	10.51	20.34	18.25	89.72	12.71
T_6	21.52	19.31	89.73	13.45	23.90	21.73	90.92	15.23	23.30	21.90	90.12	15.29
T_7	18.92	15.86	83.80	10.68	18.90	16.19	85.70	11.03	20.03	16.44	82.10	10.95
CD (P = 0.05)	2.28	1.67	5.65	2.78	NS	1.58	3.94	2.44	NS	NS	NS	NS

Treatment details are given in text
CCS, Commercial cane sugar

($R^2 = 68.42$)*

Cane quality

Quality parameters such as brix, pol(%) juice, purity and commercial cane sugar (CCS%) were considered (Table 3). During all the years, values of brix were found higher in treatment receiving protective irrigation as against a lowest where ratooning was practiced. However, the treatment receiving extra 40 kg K/ha and mulching and found best and remained very close to the highest (Table 3). Similar observations were also made in pol(%) juice, purity(%) and CCS(%) (Table 3). Foliar application of K and N although influenced the quality parameters, their effect was not as good as soil application of extra K with mulch. In contrast, no differences either due to soil application or foliar spray of K on quality parameters were reported (Jayabal and Chockaligam, 1990).

Sugar-recovery values were higher in treatment receiving protective irrigation (10.53%) and treatment receiving 40 kg/ha extra K along with mulching (10.55%). Even application of just 40 kg extra K yielded (10.21%) similar results and remained at par with T_3 and T_6 treatments. Effects on sugar recovery by other treatments remained non-significant compared to check.

A highest mean sugar yield (Table 1) was recorded where protective irrigation was given due to higher cane yield and improved quality parameters (Table 3). Sugar yield depended more on cane yield and to a lesser extent on quality indices. A lowest mean sugar yield (Table 1) was in treatment where the ratooning was encouraged due to lower cane yield. Sugar yield due to soil application (extra K @ 40 kg/ha with or without mulch) was as good as crop experiencing no stress.

Table 4. Correlation between cane and sugar yields and their attributing parameters of sugarcane

	1989	1990	1991	Pooled
Yield vs				
Cane length	0.9478**	0.8701**	0.9664**	0.7168**
Cane girth	0.8464**	0.9341**	0.8664**	0.6352**
Cane diameter	0.8360**	0.8540**	0.8096**	0.8433**
Sugar yield vs				
Cane yield	0.8941**	0.9510**	0.9824**	0.9252**
Brix (%)	0.6106*	0.9667**	0.8728**	0.7753**
Pol (%) juice	0.6308*	0.9848**	0.8886**	0.7487**
CCS (%)	0.7660**	0.9859**	0.9788**	0.8047**
Critical value	*P = 0.05*	*P = 0.01*		
For years	0.6765	0.7532		
For pooled	0.3694	0.4318		

* P = 0.05; ** P = 0.01

A strong correlation (Table 4) existed between sugar yield (Y) and cane yield (x_1), brix (x_2), pol(%) juice (x_3) and CCS(%) (x_4) and were considered for regression analysis:

1989

$Y = 12.9623 + 0.0672\ x_1 + 1.3036\ x_2 - 2.0\ x_3 + 1.8901\ x_4$

$(R^2 = 92.22)^*$

1990

$Y = 6.5327 - 0.036\ x_1 + 65.6926\ x_2 + 0.1892\ x_3 - 0.3897\ x_4$

$(R^2 = 98.17)^*$

1991

$Y = 4.7153 + 0.1108\ x_1 + 0.2802\ x_2 + 0.1902\ x_3 - 0.3897\ x_4$

$(R^2 = 96.65)^*$

Pooled

$Y = 5.4597 + 0.086624\ x_1 + 0.0601\ x_2 - 1.3553\ x_3 + 1.4162\ x_4$

$(R^2 = 89.79)^*$

Thus soil application of extra K @ 40 kg/ha with a mulch before last irrigation was found effective in evading moisture stress during the canal lean period.

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