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Agronomic Responses of Sugarcane (*Saccharum officinarum* L.) Ratoon to Natural and Synthetic Supplements under Water Deficit Conditions

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Abstract

Sugarcane (*Saccharum officinarum* L.) is one of four major cash crops with high importance for sugar industry in Pakistan. The objective of this study was to evaluate biomass of ratoon sugarcane in response to organic supplements and coated fertilizer under three irrigation levels. The experimental design was a randomized complete block design (RCBD) with split plot arrangement of factors, replicated three times. Ratoon sugarcane clone CPF-249 was exposed to four levels of natural amendments or synthetic fertilizers and three irrigation levels during two growing seasons. Results suggested significant effects of dose and time of synthetic fertilizer application on all agronomic traits. All quality parameters were statistically non-significant, except for cane sugar recovery% (CSR) and commercial cane sugar concentration (CCS). Results of this study indicate that maximum millable cane yield was achieved under 100% irrigation and polymer coated Single Super Phosphate (SSP) fertilizer during 2016-17 with production of 13.2 stalks/m^2 and 14.1stalks/m^2 whereas, millable cane yield was reduced in both treatments in 2017-18. Maximum stripped cane yields of 47.7 and 40.8 t ha^{-1} were recorded under 100% irrigation level and polymer coated SSP fertilizer, respectively. A significant reduction in yield was observed at 50% irrigation and no fertilizer application. The maximum cane sugar recovery of 14.0 and 13.6% was achieved when plants were treated with polymer coated single super phosphate (SSP) fertilizer under 100% of recommended irrigation during the 2nd growing season.

Keywords: Cane yield, Irrigation levels, Soil amendments, Single super phosphate,
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Introduction

Sugarcane is a major cash crop in Pakistan and is used to produce sugar and other byproducts, including forage. Low availability of mineral nutrients is a major problem in Pakistan. Higher requirement for nitrogen results from its immobilization in the soil, shallow roots and seasonal root rotting of cane plant (Lal and Singh, 2008). Highly withered soils in the tropics and sub-tropics, as well as calcareous soils are deficient in phosphorous (Hinsnger, 2001). Therefore, a surplus phosphorus fertilization is becoming inefficient and ecological unsounded practice, because the efficiency of the added phosphorus fertilizer can be as low as 10% (Werft and Dekkers, 1996).

The main contributing factor of potassium deficiency in crops is insufficient soil K content (Kerby and Adams, 1985). The relationship between the K content in soil and the occurrence of K deficiency is not direct (Bedrossian et al, 2000). K deficiency in plants can occur on soils with both high or low K levels (Cassman et al, 1989; Wright, 1999). Water deficiency negatively affects cane production. Sugarcane ratoon is a cost-effective crop due to additional input savings on seeding material, soil preparation, and other management practices (Shukla et al., 2013). From commercial point of view, ratoon also help sooner initiation of the crushing season from milling perspective as cane maturation and accomplishment of growing degree days (GDD) will be achieved in sooner time when compared with planted cane. Bhatnagar et al., (2003) reported that variation in ratoonablility in sugarcane is genetic in nature. Saeed (1993) found that yield potential of sugarcane ratoon under local conditions of Punjab, Pakistan depended on proper management practices such as timely sowing, execution of optimum interculture and fertilizer as well as irrigation events. Such margin of management for yield improvement is critical to estimation and scheduling of irrigation water based on crop responses at critical stages of cane growth (Geerts and Race, 2009; Mahan et al., 2012). Ratoon production is one way to control an efficient use of inputs i.e. labor, land, water and capital. Hence, higher water use efficiency continues to be an important trait for sugar industry in this part of the globe where soils have fine alluvial texture with variable water holding capacity (Mahesh et al., 2013).

Certain physiological processes, i.e., photosynthesis, transpiration, stomatal conductance, biomass portioning and transpiration, are highly affected by soil water availability (Taiz and Zeiger, 2006). Water deficiency stress reduces photosynthesis, resulting in a rapid reduction in growth and developmental traits (Chaves et al., 2009). Sugarcane productivity and sucrose accumulation can be improved by invigorating its physiological and morphological properties (Edmeades et al., 2004; Inman-Bamber et al., 2005). Mineral nutrition is critical for growth and development of cane. Alluvial soils vary in fertility; thus, the utilization of natural and synthetic amendments may help achieve better productivity of cane (Ibrahim et al., 2008). Press-mud, a byproduct of sugarcane crushing, is a useful manure used for increasing soil fertility in Indo-Pak subcontinent. The application of press-mud can replace commercial fertilizers and increase soil organic matter and soil mineral nutrients (Bokhtiar et al., 2001; Razzaq, 2001). In addition, other physical properties of soils such as porosity, texture and structure as well as organic matter proportion are also improved (Rangaraj et al., 2007). Reddy (2002) found that sugarcane press-mud is a potential source of minerals (Ca-2.40 % Mg-1.28 %, S-2.62 %) and microelements (Fe-2042.0 ppm, Cu-22.6 ppm, Mn-228.0 ppm, Zn-36.5 ppm).

Application of superabsorbent polymers can improve soil structure, water holding capacity and availability of nutrients, and ultimately increase crop yield. Prevedello and Loyolla (2007) discouraged the use of polymers in clay soils because of their antagonistic effects on water percolation in the soil profile. Oliveira et al. (2004) tested a water porous polymer in cane production and found more water retention, profuse sprouting and increased tillering during early growth phase. Islam et al. (2011) revealed that utilization of polymers had a significant effect on the improvement of crop productivity in water deficient soils. In addition, the polymer-coated supplement can exploit soil manure and compost till five years of their application (Martin, 1997). Shao et al. (2007) reported that hydrophilic polymers helped in retention of soil water and reduced salt concentration levels in roots. The use of polymers can also limit the exchange of K+ and Ca2+ through a buffering action. Information on the effects of soil water deficit and applied supplements is needed to improve of cane yield and reduce the cost of production. The objectives of this study were (1) to evaluate the growth responses of sugarcane to natural and synthetic supplements and different irrigation levels, and (2) to assess profitability of sugarcane production using cane byproducts and artificial amendments under local conditions of Pakistan.

Material and Methods

The experiments were conducted at the Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan (31.25°N, 73.09°N Longitude, altitude 184 m). The weather data during the study period are presented in Fig 1. During Both 1st and 2nd years of ratoon, the design used was kept uniform i.e. randomized complete block design (RCBD) with a split-plot arrangement of experimental factors that was replicated three times. The plot size was 10 × 6 m. Ratoon sugarcane clone CP-249 was exposed to four levels of natural and synthetic supplements and three irrigation levels during the ratoon years under experiment. The dose of polymer coated SSP, press-mud and cane trash boiler ash + 50% potassium sulphate (SOP) at 112 kg ha-1 and 3263 kg ha-1, respectively and were applied as same dose in both years. Irrigation levels were maintained at 100% of recommended irrigation (16 irrigations), 75% of recommended irrigation (12 irrigations) and 50% of recommended (8 irrigations) for the whole growing season. Soil amendments were applied in subplots comprising of control, press-mud, polymer-coated single super phosphate (SSP) and 50% cane trash boiler ash + 50% potassium sulphate (SOP) in both years.

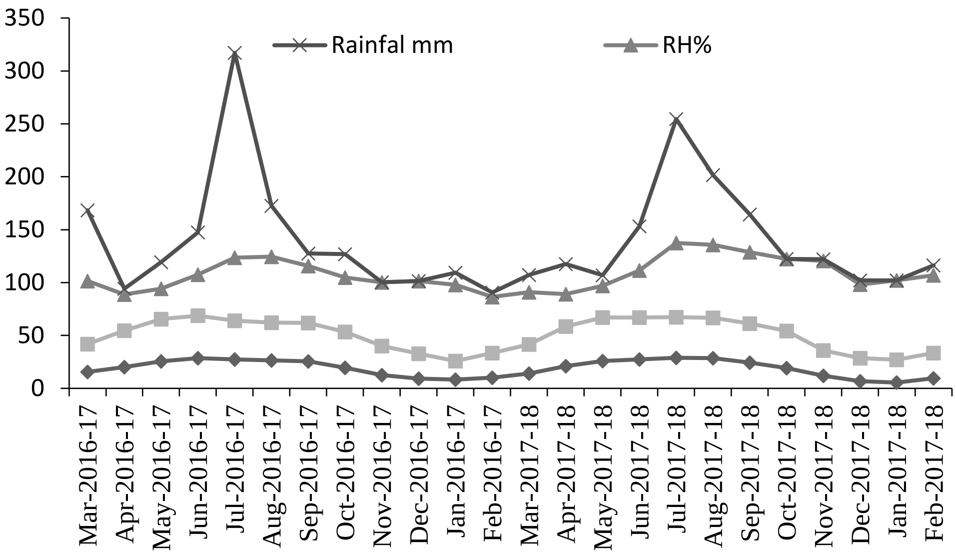

Figure1. Weather data during length of the experiment

The sugarcane ratooning experiments were started in the 2nd week of February 2016 and 2017 and harvested on the 3rd week of February 2017 and 2018, respectively. The total rainfall amount received during the length of the experiment was 758 mm. Cane samples were collected at the time of maturity and cane juice was squeezed with crusher. Juice quality was evaluated according to Spancer and Meade (1955).

The percentage of commercial/cane/sugar (CCS %) was determined according to the procedure by Spancer and Meade (1963).

$$\text{CCS (\%)} = \frac{3}{2}\,\text{P}\left(1 - \frac{\text{F}+5}{100}\right) - \frac{1}{2}\text{B}\left(1 - \frac{\text{F}+3}{100}\right)$$

where P = Pol.% in juice, polarity that shows the presence of sucrose content

B = Brix% in juice, the presence of total soluble solids

F = fiber % in juice

Cane sugar recovery percent (CSR%) was calculated by the following formula (Spancer and Meade, 1963):

CSR (%) = CCS (%) x 0.94

where CCS = commercial cane sugar

Fisher's Analysis of Variance and Tukey's Honestly Significance Difference test were applied to analyze the effects of soil amendments and irrigation levels. Mean significance was declared at the 0.05 probability level (Steel *at el*., 1997). Statistix 8.1computer software program was used for analysis (Analytical Software, USA).

Results

The effects of soil amendments and irrigation levels on the number of tillers, number of millable canes, cane length, internodes per cane, internodal length, cane girth, stripped cane weight, stripped cane yield, and unstripped cane weight are shown in Table 1. and Table 2. for the 1st and 2nd ratooning in 2016-17 and 2017-18, respectively. The number of tillers was not significantly affected either by irrigations levels or soil amendments in both growing seasons, but it was lower in the second growing season. The number of millable canes was significantly affected by soil amendments and irrigation. The polymer coated SSP+100% recommended irrigation amount resulted in the highest number of millable canes. The number of millable canes was reduced in the second growing season. The effects of other levels of experimental factors on the number of millable canes were not statistically different.

The longest cane length was observed in response to polymer coated SSP and 100% recommended irrigations (16 irrigations) in 2016-17 and 2017-18. The shortest cane length was measured at the 50% recommended irrigation level and in the control treatment where no amendment was applied.

The number of internodes per cane was significantly affected by soil amendments in 2016-17 and 2017-18. The highest number of internodes was produced in response to the polymer coated SSP amendment at 100% recommended irrigation level (16 irrigations). The lowest number of internodes was measured at in the 50% recommended irrigation level (8 irrigations). In 2017-18, the number of internodes was reduced due to less ratooning potential whereas, this remained at par under different soil amendments treatments.

Internodal length was significantly affected by soil applied amendments and irrigation levels. Internodal length was greater in the polymer coated SSP than other fertilizer treatments in both growing seasons. The greatest and the least internodal lengths were observed under 100% and 50% recommended irrigations levels (16 or 8 irrigations), respectively, in 2016-17. In the second growing season, the intermodal lengths were similar at the 100% and 75% recommended irrigation levels and greater than that at the 50% recommended irrigation level. The intermodal length was reduced in the second growing season.

Soil applied fertilizer and irrigation treatment significantly affected cane girth in 2016-17 and 2017-18 (Table 2.). The greatest cane girth was achieved when plants were exposed to polymer coated SSP. The other treatments had no effect on cane girth. A greater cane girth was measured in plants subject to 100% recommended irrigation when compared with plants grown at 50% recommended irrigations during 2016-17. However, cane girth was reduced under both soil-applied supplements and irrigation regimes during 2017-18.

Stripped cane weight was significantly affected by soil amendments and irrigation regimes in both years. The highest stripped cane weight was recorded in plants subject to polymer coated SSP when compared to that measured in plants grown at other treatments. Stripped cane weight was higher in plants subject to 100% recommended irrigation level when compared to that at 50% irrigation level during 2106-17 and 2017-18; however, stripped cane weight was lower in the second growing season.

Stripped cane yield was affected by the irrigation level in both growing seasons. The highest stripped cane yield was recorded in plants subject to 100% recommended irrigation that is followed by 75% recommended irrigation, while the least stripped cane yield was achieved under 50% recommended irrigations. Effects of soil amendment treatments were also statistically significant. The highest stripped cane yield was harvested from plants subject to polymer coated SSP, while other treatments were not significantly different in both growing seasons. Stripped cane yield was lower in the second growing season.

Irrigation levels and soil amendments significantly affected total biomass yield of un-stripped cane (Table 3.). The highest biomass yield of un-stripped cane was produced at 100% recommended irrigation and the least yield was noted at 50% recommended irrigations in both years. Plants subject to polymer coated SSP produced the highest biomass yield of unstripped cane, while other soil amendments did not affect biomass yield. The unstrapped cane yield was less in 2017-18.

Effects of soil amendments and irrigation levels on cane tops weight, cane trash weight, harvest index, brix, pol., cane juice purity, fiber content, CCS and cane sugar recovery are presented in Table 3 and 4 Cane top weight was the highest under polymer coated SSP and similar in other soil amendment treatments in both growing seasons. The highest cane tops weight was noted at 100% recommended irrigations and the lowest weight was noted at 50% recommended irrigations in 2016-17. Cane tops weight was reduced in the second growing season.

The data regarding cane trash weight showed statistically non-significant relationship against all soil applied amendments in different years but the significant response was shown under various irrigation regimes. Highest cane trash weight was recorded in control (100% recommended irrigation) that is statistically at par with 75% recommended irrigation and the lowest trash weight was recorded under 50% recommended irrigation. However, cane trash weight was reduced in 2017-18 season when exposed to both factors (irrigation and soil amendments)

Significantly highest harvest index was recorded when plants were subject to polymer coted SSP, while other soil amendments had non-significant effect when studied during 2106-17 and 2017-18. The harvest index values were similar at 100% and 75%

recommended irrigation levels and were higher than the recorded harvest index at 50% recommended irrigation level during both growing seasons.

Soil applied fertilizer and different irrigation regimes had no significant effect on brix and pol concentrations in both growing seasons.

The highest commercial cane sugar concentration was measured under 100 % recommended irrigations, while the lowest one was measured under 50 % recommended irrigations in both growing seasons. The highest cane sugar concentration was measured in the polymer coated SSP, while the lowest cane sugar concentration was measured under control treatment in both growing seasons. Similar, cane sugar recovery was highest under 100 (%) recommended irrigations and lowest under 50 % recommended irrigations in both growing seasons. Maximum cane sugar recovery was calculated in the polymer coated SSP but it was not significantly different from that measured in press-mud and cane trash boiler ash + 50 % SOP treatments preceding both growing seasons. All quality parameters tended to decrease in 2017-18. The interactive effect of natural and synthetic soil supplements under different water deficit levels were not significant for all yield attributes.

Table 1. Effect of irrigation levels and soil applied amendments on tillers, millable canes, cane length, internodes/cane and internodal length

Treatments	Tillers m^{-2}		Millable canes m^{-2}		Cane length (cm)		Internodes $cane^{-1}$		Internodal length (cm)	
	2016-17	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
I_0 = 100% recommended irrigation (16 irrigations)	14.1	12.4	13.6 a	13.3 a	206.6 a	201.6 a	16.3 a	15.0 a	14.3 a	12.5 a
I_1 = 75% recommended irrigation (12 irrigations)	13.5	12.1	13.2 a	12.6 a	194.8 b	189.8 b	14.3 b	13.0 b	12.7 b	11.2 a
I_1 = 50% recommend	13.6	11.8	10.4 b	09.4 b	176.8 c	172.6 c	10.9 c	10.2 c	8.8 c	07.3 b

ed irrigation (8 irrigations)										
HSD ($p \leq 0.05$)	**NS**	**NS**	**1.5**	**1.80**	**3.09**	**5.88**	**1.30**	**0.76**	**1.41**	**1.41**
T_o = Control	12.6	11.8	11.7 b	11.0 b	176.7 c	172.2 c	13.0 b	11.9 b	10.5 c	08.9 c
T_1 = Press-mud	12.7	12.1	12.0 b	11.4 b	191.3 b	186.9 b	13.1 b	11.9 b	11.6 b	10.0 b
T_2 = Polymer coated SSP	14.2	12.5	14.1 a	13.4 a	206.9 a	202.4 a	15.1 a	14.0 a	13.4 a	11.8 a
T_3 = 50% cane trash boiler ash + 50% SOP	12.9	12.1	11.9 b	11.2 b	196.0 b	190.4 b	14.1 ab	12.9 ab	12.2 b	10.6 b
HSD ($p \leq 0.05$)	**NS**	**NS**	**1.51**	**1.40**	**6.8**	**6.56**	**1.21**	**1.20**	**0.83**	**0.82**
$I_0 \times T_0$	14.0	12.0	12.9	12.3	197.0	188.0	15.5	14.2	13.2	11.4
$I_0 \times T_1$	13.7	12.0	13.0	12.8	205.3	200.3	15.4	14.1	13.9	12.1
$I_0 \times T_2$	15.6	13.2	15.3	14.8	220.0	215.0	17.7	16.4	16.0	14.2
$I_0 \times T_3$	14.0	12.7	13.3	13.0	208.0	203.0	16.6	15.3	14.1	12.3
$I_1 \times T_0$	13.0	12.0	12.3	11.6	180.0	175.0	13.2	11.9	11.4	9.9
$I_1 \times T_1$	13.5	12.5	12.7	12.0	192.0	187.0	13.6	12.3	12.3	10.8

$I_1 \times T_2$	14.0	12.3	14.8	14.2	210.3	205.0	15.8	14.5	14.0	12.5
$I_1 \times T_3$	15.6	11.7	13.0	12.4	197.0	192.0	14.8	13.5	13.3	11.8
$I_2 \times T_0$	11.0	12.0	10.0	9.1	157.0	153.7	10.3	9.8	7.0	5.5
$I_2 \times T_1$	11.3	12.0	10.3	9.2	176.7	173.3	10.4	9.5	8.7	7.2
$I_2 \times T_2$	13.0	12.0	12.1	11.1	190.3	187.0	12.0	11.2	10.3	8.8
$I_2 \times T_3$	11.4	12.0	9.3	8.3	183.0	176.3	11.0	10.1	9.3	7.8
HSD ($p \le 0.05$)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 2. Effect of irrigation levels and soil applied amendments on cane girth, stripped cane mass, stripped cane yield and unstripped

Treatments	Cane girth (cm)		Stripped cane mass (kg)		Stripped cane yield (t ha^{-1})		Unstripped cane yield (t ha^{-1})	
	2016-17	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
I_0 = 100% recommended irrigation (16 irrigations)	1.8a	1.7 a	0.9 a	0.8 a	47.7 a	42.1 a	66.3 a	60.6 a
I_1 = 75% recommended irrigation (12 irrigations)	1.7 b	1.7 b	0.8 b	0.7 b	43.9 b	38.3 b	61.1 b	57.5 b
I_1 = 50% recommended irrigation (8 irrigations)	1.6 c	1.5 c	0.6 c	0.5 c	24.1 c	23.3 c	45.5 c	41.2 c

HSD (p≤0.05)	**0.05**	**0.04**	**0.08**	**0.09**	**2.26**	**2.24**	**3.00**	**1.60**
T_o = Control	1.6 c	1.6 c	0.6 c	0.6 b	37.3 c	33.3 c	56.9 b	51.5 c
T_1 = Press-mud	1.7 bc	1.5 bc	0.7 bc	0.6 bc	37.8 bc	33.8 bc	57.5 b	52.4 bc
T_2 = Polymer coated SSP	1.9 a	1.8 a	0.9 a	0.8 a	40.8 a	36.9 a	60.6 a	55.4 a
T_3 = 50% cane trash boiler ash + 50% SOP	1.8 b	1.7 b	0.8 b	0.7 b	38.3 b	34.3 b	58.1 b	52.9 b
HSD (p≤0.05)	**0.12**	**0.13**	**0.10**	**0.11**	**0.90**	**0.89**	**1.25**	**1.28**
$I_0 \times T_0$	1.7	1.6	0.8	0.7	46.2	40.6	65.1	58.9
$I_0 \times T_1$	1.7	1.7	0.8	0.8	47.4	41.8	65.2	59.7
$I_0 \times T_2$	2.0	1.9	1.1	1.0	50.1	44.5	68.7	63.2
$I_0 \times T_3$	1.9	1.8	0.9	0.8	46.9	41.3	66.0	60.5
$I_1 \times T_0$	1.7	1.6	0.6	0.5	42.7	37.1	62.3	56.7
$I_1 \times T_1$	1.7	1.6	0.7	0.6	43.0	37.4	62.4	56.9
$I_1 \times T_2$	1.9	1.9	0.9	0.9	46.5	40.8	64.9	59.4
$I_1 \times T_3$	1.8	1.7	0.8	0.8	43.5	37.9	45.7	57.2
$I_2 \times T_0$	1.5	1.5	0.5	0.4	23.0	22.2	43.3	38.9
$I_2 \times T_1$	1.6	1.5	0.6	0.5	23.0	22.2	45.0	40.7
$I_2 \times T_2$	1.8	1.7	0.7	0.6	26.1	25.3	48.0	43.7
$I_2 \times T_3$	1.7	1.6	0.6	0.6	24.4	23.6	45.7	41.3
HSD (p≤0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 3. Effect of irrigation levels and soil applied amendments on tops mass, trash mass, H.I. (harvest index) Brix % and Pol% (cont).

Treatments	Top mass (kg)		Trash mass (kg)		Harvest index		Brix%		Pol%	
	2016-17	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
I_0 = 100% recommended irrigation (16 irrigations)	21.2 a	18.2 a	6.2 a	4.9 a	71.7 a	70.7 a	19.3	19.4	15.9	15.7
I_1 = 75% recommend	17.9 b	14.9 b	6.0 a	4.8 a	69.8 a	67.7 a	19.2	19.3	16.0	15.8

ed irrigation (12 irrigations)										
I_1 = 50% recommended irrigation (8 irrigations)	14.1 c	11.1 c	5.2 b	3.9 b	52.6 b	55.6 b	19.1	19.2	15.9	15.8
HSD ($p≤0.05$)	**3.04**	**3.04**	**0.42**	**0.40**	**2.46**	**5.19**	**NS**	**NS**	**NS**	**NS**
T_o = Control	15.3 c	12.3 c	5.6	4.4	63.5 b	63.3 b	19.3	19.3	16.1	15.9
T_1 = Press-mud	17.0 bc	14.0 bc	5.7	4.5	64.0 b	64.2 b	19.1	19.0	16.1	15.9
T_2 = Polymer coated SSP	20.7 a	17.7 a	6.1	4.9	67.0 a	67.6 a	19.5	19.4	15.9	15.7
T_3 = 50% cane trash boiler ash + 50% SOP	17.9 b	14.9 b	5.7	4.5	64.3 b	63.5 b	19.2	19.1	15.8	15.6
HSD ($p≤0.05$)	**1.81**	**1.83**	**NS**	**NS**	**1.93**	**2.54**	**NS**	**NS**	**NS**	**NS**
$I_0×T_0$	19.0	16.0	5.9	4.8	70.0	68.6	19.2	19.2	15.9	15.7
$I_0×T_1$	20.3	17.3	6.0	4.9	71.9	70.7	18.7	18.7	16.4	16.2
$I_0×T_2$	24.8	21.8	6.5	5.3	74.3	74.3	19.9	19.9	16.1	15.9
$I_0×T_3$	20.7	17.7	6.0	4.8	70.7	69.4	18.8	18.8	15.5	15.3
$I_1×T_0$	15.7	12.7	5.9	4.7	68.6	66.2	19.1	19.1	16.1	15.9
$I_1×T_1$	17.3	14.3	6.0	4.8	68.9	66.5	19.0	19.0	15.9	15.8
$I_1×T_2$	20.3	17.3	6.3	5.1	72.2	70.9	19.8	19.8	16.2	15.9
$I_1×T_3$	18.3	15.3	5.9	4.7	69.4	67.1	19.2	19.2	15.9	15.7
$I_2×T_0$	11.3	8.3	4.9	3.7	51.9	55.1	19.6	19.6	16.3	16.1
$I_2×T_1$	13.3	10.3	5.1	3.9	51.2	55.4	19.4	19.4	15.9	15.7
$I_2×T_2$	17.0	14.0	5.6	4.4	54.6	57.7	18.8	18.8	15.6	15.4
$I_2×T_3$	14.7	11.7	5.2	3.9	52.7	54.1	19.5	19.5	16.0	15.8
HSD ($p≤0.05$)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 4. Effect of different irrigation level and soil applied amendments on Cane juice purity%, Fiber %, Commercial cane sugar% and cane sugar recovery %

Treatments	Cane juice purity%		Fiber%		Commercial Cane Sugar%		Cane sugar recovery%	
	2016-17	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
I_0 = 100% recommended irrigation (16 irrigations)	83.3	82.1	12.2	12.9	14.2 a	14.9 a	13.34 a	14.0 a
I_1 = 75% recommended irrigation (12 irrigations)	83.2	82.2	12.1	13.0	12.6 b	13.0 b	11.84 a	12.2 a
I_1 = 50% recommended irrigation (8 irrigations)	82.5	81.5	12.1	12.9	9.8 c	10.1 c	9.21 b	9.5 b
HSD ($p \leq 0.05$)	**NS**	**NS**	**NS**	**NS**	**1.7**	**1.2**	**1.6**	**1.1**
T_o = Control	15.3 c	12.3 c	5.6	4.4	63.5 b	63.3 b	19.3	19.3
T_1 = Press-mud	17.0 bc	14.0 bc	5.7	4.5	64.0 b	64.2 b	19.1	19.0
T_2 = Polymer coated SSP	20.7 a	17.7 a	6.1	4.9	67.0 a	67.6 a	19.5	19.4
T_3 = 50% cane trash boiler ash + 50% SOP	17.9 b	14.9 b	5.7	4.5	64.3 b	63.5 b	19.2	19.1
HSD ($p \leq 0.05$)	**1.81**	**1.83**	**NS**	**NS**	**1.93**	**2.54**	**NS**	**NS**
$I_0 \times T_0$	82.9	81.3	12.2	13.0	13.2	13.4	12.1	12.6
$I_0 \times T_1$	87.2	86.1	12.1	12.9	11.3	12.4	12.0	13.0
$I_0 \times T_2$	80.9	79.9	12.0	12.8	14.0	14.3	12.8	14.5
$I_0 \times T_3$	82.1	81.0	12.0	12.8	12.3	13.2	12.3	13.2
$I_1 \times T_0$	84.2	83.2	12.1	12.9	11.5	12.3	11.1	12.0
$I_1 \times T_1$	83.8	82.8	12.1	12.9	10.6	11.2	11.9	12.3
$I_1 \times T_2$	81.7	80.7	12.2	13.0	11.8	12.3	12.6	12.8
$I_1 \times T_3$	83.1	82.1	12.3	13.1	11.0	11.5	11.8	12.0
$I_2 \times T_0$	82.9	81.9	12.1	12.9	9.1	9.6	9.4	9.7

$I_2 \times T_1$	82.1	81.1	12.1	12.9	10.0	11.1	10.0	9.9
$I_2 \times T_2$	82.8	81.8	12.1	12.9	10.2	10.6	10.2	10.2
$I_2 \times T_3$	82.2	81.2	12.1	12.8	9.2	9.4	9.1	9.8
HSD ($p \leq 0.05$)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Discussion

Significant differences in number of canes m-2, cane weight, and stripped cane yield were observed in response to experimental treatments. Superabsorbent polymer coated SSP was reported in production of biomass in other cereals (Moslemi et al., 2011). Major emphasis of this study was to evaluate organic and inorganic sources of phosphorous and potash on sugarcane production. Well established role of SSP to significantly hold water, 10 times more water holding capacity by weight of superabsorbent polymer attracts availability of water to this C4 crop plant, the sugarcane particularly under alluvial soil parentage of the experimental site. Reportedly, superabsorbent polymer forms gel-like material which absorbs water that can be later utilized during periods of soil water deficit conditions. Ghamsari (2009) described that SSP increased the cane yield when applied @ 112 kg ha-1. Mao et al. (2011) also reported the effect of (SAP) on maize crop under drought affected soils that also had a significant effect on sugarcane crop. The strip cane yield obtained in this experiment coincides with that reported by Perumal (1999) who concluded that application of inorganic fertilizer resulted in a higher sugar cane yield when compared with organic fertilizer including press mud. These results are also supported by Viator et al. (2002) with similar conclusion of enhanced effect of inorganic fertilizers for increased cane yield than that is obtained from organic fertilizers. The interactive effect of application of soil amendments and irrigation water general insignificantly affected cane growth as well as yield however, the highest cane yield was recoded in sugarcane at 112 kg ha-1 polymer coated SSP with 100% recommended irrigations (16 irrigations) that corresponds to 64-acre inches of delta of water. Cane juice purity, brix, pol. did not respond to inorganic supplements significantly, hence, resembles to reporting of Kumar et al. (1996) and Abbasi (2005).

Conclusion

Nutrient-based amendments were highly beneficial when applied in combination with the optimum irrigation for increased cane growth and yield. However, cane trash boiler ash combination with 50% recommended K2O obtained from SOP alone significantly sustained the stripped cane yield during 1st and 2nd year of ratoon cane crop.

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