Assessment of best combination of soil amendment and different irrigation regimes to improve yield of sugarcane.

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Abstract: The studies related to effect of irrigation levels and soil amendments practices on sugarcane was conducted on a loamy soil under field conditions at Agronomic Research Farm area, University of Agriculture, Faisalabad (Latitude 31.26°N, Longitude 73,06° E and Altitude 184 m) Pakistan during growing season 2016- 17. The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangement and three replications with a net plot size of 4.8 m x 10.0 m. Planting was sown in 120 cm wide trenches using two eyed cane setts in dual rows @ 75,000 setts ha^{-1} by hand placement. Sugarcane variety CPF-249 was planted on Last week of March 2016. All agronomic operations were kept uniform except (N) nitrogen and (P) phosphorus fertilizers and time of irrigations. In experiment, potash @112 kg ha'1 was applied in trenches at the time of planting while Nitrogen and phosphorus fertilizer was applied as per treatment plan from organic and inorganic sources with irrigation combinations viz. I_0T_0 = 100% of Recommended Irrigation (16 Irrigations) + Control, I_0T_1 = 100% of Recommended Irrigation (16 Irrigations) + Press-mud, I_0T_2 = 100% of Recommended Irrigation (16 Irrigations) + Polymer Coated SSP, I_0T_3 = 100% of Recommended Irrigation (16 Irrigations) 50% Cane Trash boiler ash+50% SOP, I_1T_0 = 75% of Recommended Irrigation (12 Irrigations) + Control, I_1T_1 = 75% of Recommended Irrigation (12 Irrigations) + Press-mud, I_1T_2 = 75% of Recommended Irrigation (12 Irrigations) + Polymer Coated SSP, I_1T_3 = 75% of Recommended Irrigation (12 Irrigations) + 50% Cane Trash boiler ash+50% SOP, I_2T_0 = 50% of Recommended Irrigation (08 Irrigations) + Control, I_2T_1 = 50% of Recommended Irrigation (08 Irrigations) + Press-mud, I_2T_2 = 50% of Recommended Irrigation (08 Irrigations) + Polymer Coated SSP, I_2T_3 = 50% of Recommended Irrigation (08 Irrigations) + 50% Cane Trash boiler ash+50% SOP. Effect of irrigation levels and soil amendments techniques on trash weight (t ha'1) and harvest index remained non- significant. The highest number of tillers m^{-2} (15.63) was recorded at I_0T_2 (100% of recommended irrigation + polymer coated SSP) and minimum m^{-2} (11) at I_1F_1 (75% of recommended irrigation + pressmud). The maximum cane girth (2.00 cm) was recorded at I_0T_2 (100% of recommended irrigation + polymer coated SSP), cane length (220.00 cm) at I_0T_2 (75% of recommended irrigation + polymer coated SSP), weight per stripped cane (1.09 kg) at I_0T_2 (100% of recommended irrigation + polymer coated SSP). While minimum cane girth (1.5 cm) was recorded at I_2F_0 (50% of recommended irrigation + control), cane length (157 cm) at I_2T_0 (50% of recommended irrigation + control), weight per stripped cane (0.51 kg).

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Introduction

Incredible rise in human populace is having exhaustive effect on natural resources. Subsequently, more per capita food consumption per unit time can only be met by mass food production. Sugarcane is a primary crop to fulfill table sugar needs of the common people due to its resourceful metabolism. The sugarcane contribution in GDP and value addition of Pakistan is 0.7% and 3.4%, respectively and nearly 1.22 million hectares are cultivated and production of cane stood at 73.6 million tones (Govt. of Pakistan, 2016-17). In Pakistan, average yield of cane is 60.4 tons ha^{-1}. Sugarcane have second position in cash crops of Pakistan, after cotton (Govt. of Pakistan, 2017).

Commonly, the poor agricultural practices, conventional planting techniques and improper utilization of nutrients are the major causes of low cane yield and sugar recovery. In Pakistan and over the world, the cane growing communities apart from growers to use the best management practices to maximize output. Hence, balanced nutrition results in per unit soil productivity as well as better cane yield. Sugarcane ratoon crop is highly exhaustive with respect to soil nutrition as it needs more nitrogen than planted cane because massive damage of roots and high rate of immobilization of soil nitrogen (Lal and Singh, 2008). As a result of persistent usage of chemicals and inorganic fertilizer in agriculture the soil has been extremely harmed. It has eradicated to lessen soil micro-biota useful for making unavailable nutrients to available form hence decrease natural resources of soil fertility (Kremer and Li, 2003). Press-mud is comprised of nitrogen, phosphorus, potash and basic nutrients and it improves the soil physical and chemical properties (Rangaraj *et al.,* 2007). The higher amount of nitrogen, phosphorus and potassium in press-mud has finished thevalue of nutrients strength (Rakkiyappan *et al.,* 2001).

Press-mud contains minerals, phosphorus, calcium and natural carbon. Due to consistent utilization of press-mud it consequent of phyto-toxicity and nitrogen immobilization in plants and soil (Negro *atel*.,1999). Unfavorable weather elements, for instance, low rainfall, meager soil nourishment, high solar radiation in the dry spell, water logging, low temperatures and saline soils stunt growth, development and yield of cane to more a greater extent (Tahir et al., 2018; Enyard *et al*., 2005). Vital abiotic factors reasons for low cane production at farmers field to obsolete planting technique, poor intercultural operations and imbalance nutrition those outcomes in low plant population, sugarcane lodging, thin cane low sugar recovery as well as cane weight (Ali *et al*., 2009). Under dry and arid conditions, cane development retards not just because of the evapotranspiration in cane fields but also due to the shortage of water supply as medium for take-up of the supplements from soil, as a reactant in plant metabolic process and last however not the minimum in translocation of photoassimilates in plants. (Taiz and Zeiger, 2010). At certain growth and phonological stages, the slow releasing fertilizers are getting fame as those ensure supply of nitrogen for a longer period to soil hence proved successful in gathering plant necessities (Nash *atel*., 2103). Macro and micro nutrients are important to fulfill the growth and development of sugarcane to improve the source sink association and enhance sugarcane yields by getting a more biomass an inference of its C_4 (Fageria *et al*., 2009; Aslam et al., 2018).

Polymers are safe to use with non-destructive nature, easily soluble having dissolvable base and potassium parts with no releasing up (Martin, 1997). To facilitate undesirable fertilizers sickness from the topsoil, use of super absorbent polymer (SAP) in the field of agronomy could be a suitable absorber of water contents and manure nutrients closefisted developed for semi-arid regions of Northern China and exceptionally dry zones. In addition, the polymers coated supplement can handle on soil manure and compost up to five years along these application (Martin, 1997). Shao *et al.,* (2007) depicted that hydrophilic polymers helped in retention of soil water sensible to plant roots by discouraging salt concentration levels. In this way use of polymers also limit the exchange of K^+ and Ca^{2+} through buffering action.

Investigation for recognizable proof of better of better agronomic management as far as appropriate cane nutrition especially under water scarce conditions has turned out to be unavoidable for country like Pakistan because of geopolitical reasons and expected letdown of Indus Basin Treaty. Hence, planned study was target:

- To evaluate the yield response of sugarcane ratoon to natural and synthetic soil supplements / composts under water scarcity.
- To assess the best combination of soil amendment and different irrigation regimes to improve the development and yield of sugarcane ratoon.

Materials and methods

An experiment was conducted on directorate farm of University of Agriculture Faisalabad during 2016-17 to estimate the impacts of soil amendments practices on agronomic parameters of spring planted sugarcane (Saccharum Officinarum L.) under water deficit conditions.

Treatments:

Factor A. Irrigation Scheduling:

I_0 =100% of Recommended Irrigation (16 Irrigations), I_1 =75% of Recommended Irrigation (12 Irrigations). I_2 =50% of Recommended Irrigation (08 Irrigations).

Factor B. Organic and Coated Fertilizer

T_0 = Control, T_1 =Press-mud (obtained from sugar mills), T_2 = Polymer Coated Single Super Phosphate (SSP), T_3 = 50% Cane Trash boiler ash + 50 % Sulphate of Potash (SOP).

Crop husbandry

Preparation of seed bed

The experimental soil was prepared well. by deep ploughing through disk and well-rotted farmyard manure (FYM) was applied to increase the efficiency of soil. Moreover, all the optional doses of press mud, bio organic phosphorus, and polymer coated SSP and chopped cane leaves with artificial fertilizer with the ratio of 50:50 percent respectively applied at the time of sowing.

Sowing of Crop:

Sugarcane ratoon crop with variety CPF-249 was selected for experimental purpose. However, crop was planted during mid of March 2016 and harvested during 15th February, 2017 and kept as a ratoon crop for the next year. During next year 2018, ratoon crop of sugarcane was harvested at 20th of February and data regarding parameters were recorded from that crop.

Fertilization and Earthing up:

Synthetic fertilizer, integrated with organic amendments were applied @ 168 kg/ha of nitrogen, 112 kg/ha of P_2O_5, and 112 kg/ha of K_2O. However, resources for synthetic fertilizers include urea, SOP and K_2O and for organic based fertilizers these were bioorganic phosphorus, polymer coated SSP, chopped cane leaves and press mud. At the time of sowing all recommended dose of synthetic fertilizers including phosphorous and potash and 1/3rd of nitrogen were applied as a basal dosage and broadcasted. However, remaining amount of nitrogen was used to crop in two splits, 1/3rd at initial stage of tillering. Moreover, after 90 days of germination earthing-up of sugarcane was done.

Harvesting of Crop

At physiological maturity the harvesting was done manually on 18th Feb. 2018.

Recording Observations

Data pertaining to the subsequent parameters were measured by applying standard procedures during the course of study. Following observations were recorded like Number of tillers per m^2, cane length (cm), cane diameter (cm), Stripped cane yield (tons ha^{-1}), cane tops weight (tons ha^{-1}), cane trach weight, harvest index.

Experimental Design and Treatments:

A field trial was done in Randomized Complete Block Design (RCBD) under split plot arrangements having three replications. The net plot sizes were 10.00 m × 6.0 m with 5 rows.

Main path (1.5 m)																
I_0						I_1					I_2					
N.E.P	T_0	T_2	T_1	T_3	P. boundary (0.5 m)	T_1	T_3	T_2	T_0	P. boundary (0.5 m)	T_1	T_0	T_3	T_2	N.E.P	
Sub-water Channel (1 m)																
I_2						I_0					I_1					
N.E.P	T_3	T_1	T_0	T_2	P. boundary (0.5 m)	T_0	T_3	T_1	T_2	P. boundary (0.5 m)	T_3	T_1	T_0	T_2	N.E.P	Main water channel (1.5 m)
Sub-path (1 m)																
I_1						I_2					I_0					
N.E.P	T_1	T_2	T_0	T_3	P. boundary (0.5 m)	T_1	T_2	T_3	T_0	P. boundary (0.5 m)	T_2	T_3	T_1	T_0	N.E.P	
Sub-water Channel (1 m)																

Results and discussion

The trial was executed to study, the influence of various soil amendments to improving the agronomic parameters as well as WUE of spring sown sugarcane (Saccharum officinarum L.). Water use efficiency and sustainable application of nutrients are very significant factors influencing growth and development of sugarcane, especially spring planted. Inappropriate use of irrigation water and fertilizer amendments are the unbeatable problems, reducing per hectare yield of sugarcane. The study was directed to check the impacts of different irrigation levels along with fertilizer managing practices. Data were collected on Number of tillers per plant, Cane length (cm), Number of internodes per cane, Cane girth (cm), Stripped cane yield (t ha^{-1}), Tops weight (t ha^{-1}), Harvest index (%), Trash weight (t ha^{-1}) analyzed statistically and interpreted.

Number of tillers per plant:

Tillering is considered as a significant yield parameter of sugarcane crop and plays a major role in the final yield of cane. The data given (table- 1) showed that irrigation level had highly significant effect on the number of tillers per single plant. The more number of tillers per single plant (14.32) were obtained in I_0 (100% recommended irrigation 16 irrigations) against the minimum number of tillers per plant (11.63) at I_2 (50% of recommended irrigation 8 irrigations). While the number of tillers per plant increasing by soil applied amendments the all-out number of tillers (14.21) was gathered in T_2 (polymer coated SSP). The significant outcome of treatments for tillers per plant was maybe due to genetic potential of variety or availability of moisture in sufficient amount needed for tillering. However, combined effects of both factors and alone results of fertilizer application were non-significant for tillers per plant.

Cane length (cm):

Length of can stalk is a significant quantitative yield component that is positively associated with stripped cane yield of sugarcane. Data regarding the cane length are presented in Table 3. Results showed that levels of irrigation and kinds of fertilizer markedly affected the cane length. Statistically significant highest cane length (206.58 cm) was recorded in I_0 (100% of recommended irrigation) followed by cane length (194.83 cm) was recorded in the I_1 (75% of recommended irrigation) while the minimum cane length (176.75 cm) was recoded in I_2 (50% of recommended irrigation). On the other hand, the fertilizer effects the maximum cane length (206.9 cm) was observed in the T_2 (polymer coated SSP) that statistically at par with T_3 (50% Cane Trash boiler ash+50% SOP), T_1 (Press-mud) and T_0 (control) having the cane length (176.6 cm) which is statistically significant than other treatments. The interactive effect of irrigation and fertilizer was non-significant on the cane length.

Table 1: Analysis of Variance and effect of different irrigation level and soil applied amendments on under studied traits of sugarcane

Analysis of Variance

SOV	No. of tillers	Cane length	Cane Girth	Stripped cane yield	Cane top weight	Cane Trash weight	Harvest Index
Replication							
Irrigation (IR)	24.75**	598.57**	108**	793.92**	35.05**	41.68**	465.66**
Error Rep*IR							
Fertilizer (FR)	2.36NS	52.80**	15.30**	50.68**	24.02**	0.62NS	10.85**
IR*FR	0.20NS	0.77NS	0.13NS	1.36NS	0.44NS	0.04NS	0.65NS
Error Rep*IR*FR							
Total							

Table 2. Effect of different irrigation level and soil applied amendments on number of traits of sugarcane

A. Comparison of treatment means

Number of irrigations	Organic and Synthetic Supplements				Mean
	T_0	T_1	T_2	T_3	
I_0	14.00	13.67	15.63	14.00	14.32 A
I_1	13.00	13.46	14.00	13.50	13.50 A
I_2	11.00	11.13	13.00	11.37	11.63 B
Mean	12.67	12.76	14.21	12.96	

T_0 = Control
T_1 = Press-mud
T_2 = Polymer Coated SSP
T_3 = 50% Cane Trash boiler ash+50% SOP
I_0 = 100% of REC. Irrigation (16 Irrigations)
I_1 = 75% of REC. Irrigation (12 Irrigations)
I_2 = 50% of REC. Irrigation (8 Irrigations)
HSD value for IR = 1.40
HSD value for FR = 1.87

Means not sharing the common letter vary significantly at 5% probability level.

Table 3: Effect of different irrigation level and soil applied amendments on cane length (cm) of sugarcane

A. Comparison of treatment means

Number of irrigations	Organic and Synthetic Supplements				Mean
	T_0	T_1	T_2	T_3	
I_0	193.0	205.3	220.0	208.0	206.58 A
I_1	180.0	192.0	210.3	197.0	194.83 B
I_2	157.0	176.68	190.3	183.0	176.75 C
Mean	176.67 C	191.33 B	206.90 A	196.00 B	

T_0 = Control
T_1 = Press-mud
T_2 = Polymer Coated SSP
T_3 = 50% Cane Trash boiler ash+50% SOP
I_0 = 100% of REC. Irrigation (16 Irrigations)
I_1 = 75% of REC. Irrigation (12 Irrigations)
I_2 = 50% of REC. Irrigation (8 Irrigations)
HSD value for IR = 3.09
HSD value for FR = 6.8

Means not sharing the common letter vary significantly at 5% probability level.

Cane girth (cm):

The thickness of cane is a vital indicator of sugarcane yield. Data regarding the cane diameter are represented in Table 4which showed that irrigation and soil amendments considerably affected the cane diameter. The mean maximum cane diameter (1.83 cm) was recorded in I_0 (100% of recommended irrigation level) that statistically at par with the I_1 (75% of recommended irrigation) has the cane girth (1.83 cm) that was statistically different from other treatment I_2. The significant effect was observed in T_2 (polymer coated SSP) that gave the maximum cane girth (1.92

cm). Whereas, minimum cane girth (1.65 cm) and (1.63 cm) was observed in I_2 and T_0 (control), respectively.

Interactive effects of soil amendment treatments and irrigation levels was non-significant. The variability in cane diameter among soil amendments and irrigation level might be due to the availability of phosphorus, moisture content at growth stages and the level of light penetration which led to variable crop growth rate which resulted in variable cane diameter.

Table 4: Analysis of Variance and effect of different irrigation level and soil applied amendments on cane girth (cm) of sugarcane

A. Comparison of treatment means

Number of irrigations	Organic and Synthetic Supplements				Mean
	T_0	T_1	T_2	T_3	
I_0	1.7	1.7	2.0	1.9	1.83 A
I_1	1.6	1.7	1.9	1.8	1.78 B
I_2	1.5	1.6	1.8	1.7	1.65 C
Mean	1.63 C	1.68 BC	1.92 A	1.77 B	

T_0 = Control
T_1 = Press-mud
T_2 = Polymer Coated SSP
T_3 = 50% Cane Trash boiler ash+50% SOP
HSD value for IR = 0.04

I_0 = 16 irrigations
I_1 = 12 Irrigations
I_2 = 8 Irrigations
HSD value for FR = 0.13

Means not sharing the common letter vary significantly at 5% probability level

Stripped cane yield (tons per ha):

The yield of stripped cane is influenced by many factors i.e. total cane stalk per unit area, weight of stripped cane, cane length, millable canes at maturity and cane width. The final yield of sugarcane is a role of the interactive effects of different yield characters. Treatment means given in Table 5 exhibited that irrigation regimes and soil amendments considerably affected the stripped cane yield. The irrigation level has highly significant effects on the stripped cane yield. The highest stripped cane yield (47.67 t/ha) was recorded in the I_0 (100% of recommended irrigation) however, statistically differed from all irrigation levels. Lower stripped cane yield (24.12 t/ha) was recorded in I_2. On the other hand, effects of soil amendment treatments were also statistically significant as maximum stripped cane yield (40.89 t/ha) was recorded in T_2 (polymer coated SSP) and the lowest stripped cane yield (37.29 t/ha) was gathered in T_0 (control). Difference in stripped cane yield in irrigation levels and soil amendments might be ascribed to availability of nutrients and moisture content at growth and development stages of sugarcane. The interactive effect of different levels of irrigation and soil applied amendments on the stripped cane yield was recorded statistically non-significant.

Table 5: Analysis of Variance and effect of different irrigation level and soil applied amendments on stripped cane yield (t ha^{-1}) of sugarcane

A. Comparison of treatment means

Number of irrigations	Organic and Synthetic Supplements				Mean
	T_0	T_1	T_2	T_3	
I_0	46.17	47.43	50.13	46.93	47.67 A
I_1	42.70	43.00	46.47	43.52	43.92 B
I_2	23.00	23.03	26.07	24.4	24.12 C
Mean	37.29 C	37.82 BC	40.89 A	38.28 B	

T_0 = Control
T_1 = Press-mud
T_2 = Polymer Coated SSP
T_3 = 50% Cane Trash boiler ash+50% SOP
HSD value for IR = 2.26

I_0 = 100% of REC. Irrigation (16 Irrigations)
I_1 = 75% of REC. Irrigation (12 Irrigations)
I_2 = 50% of REC. Irrigation (8 Irrigations)
HSD value for FR = 0.897

Means not sharing the common letter vary significantly at 5% probability level.

Cane tops weight (tons/ha):

The total amount of cane tops produced represent the growth and development of sugarcane crop. Weight of tops is a major photosynthetic organ as it directly influences the sugarcane photosynthesis and indirectly affects the lodging, thus influencing the quality of cane. Significant differences between the various treatments were found when data pertaining to tops weight of can were analyzed statistically, Table 6.

The data revealed that the maximum cane tops weight (21.12 t/ha) was observed in the I_0 (100% of recommended irrigation level) that was statistically at par with the other treatments. While, lowest cane tops weight (14.08 tons/ha) was observed in the I_2 (50% of recommended irrigation). The soil amendments application also showed statistically significant behavior on the cane tops weight as T_2 (polymer coated SSP) gave maximum cane tops weight (20.71 tons/ha) against the lowest cane tops weight (15.35 tons/ha), recorded in the T_0 (control). The combine effects of irrigation and amendments were non-significant on the cane tops weight statistically.

Table 6: Analysis of Variance and effect of different irrigation level and soil applied amendments on cane tops weight (t ha^{-1}) of sugarcane

A. Comparison of treatment means

Number of irrigations	Organic and Synthetic Supplements				Mean
	T_0	**T_1**	**T_2**	**T_3**	
I_0	19.05	20.33	24.8	20.67	21.12 A
I_1	15.67	17.33	20.33	18.33	17.92 B
I_2	11.33	13.33	17.00	14.66	14.08 C
Mean	15.35 C	17.00 BC	20.71 A	17.89 B	

T_0 = Control **I_0 = 100% of REC. Irrigation (16 Irrigations)**
T_1 = Press-mud **I_1 = 75% of REC. Irrigation (12 Irrigations)**
T_2 = Polymer Coated SSP **I_2 = 50% of REC. Irrigation (8 Irrigations)**
T_3 = 50% Cane Trash boiler ash+50% SOP
HSD value for IR = 3.038 **HSD** value for FR = 1.83

Means not sharing the common letter vary significantly at 5% probability level.

Trash weight (t/ha):

The weight of trash of sugarcane represents the vegetative growth potential of crop. The analysis of the data pertaining to trash weight as affected by different level of irrigation and soil applied amendment are depicted in Table 7. The data regarding trash weight per hectare showed statistically non-significant interaction among the treatments under different irrigation levels and soil amendments. The highest trash weight (6.18 t/ha) was recorded in I_0 (control) which was statistically similar with I_1 (75% of recommended irrigation level) against the lower cane trash weight (5.17 tons/ha) recorded in the I_2 (50% of recommended irrigation).

The soil amendments also showed non-significant effects on the cane trash weight but the T_2 (polymer coated SSP) gave the higher cane trash weight (6.15 t/ha) and lower trash weight (5.59 t/ha) was recorded in the T_0 (control). The shared effect of levels of irrigation and soil amendments application was statistically non-significant.

Table 7: Analysis of Variance and effect of different irrigation level and soil applied amendments on cane trash weight (tons/ha) of sugarcane

A. Comparison of treatment means

Number of irrigations	Organic and Synthetic Supplements				Mean
	T0	**T1**	**T2**	**T3**	
I0	5.99	6.17	6.53	6.03	6.18 A
I1	5.93	6.00	6.27	5.93	6.03 A
I2	4.85	5.05	5.64	5.15	5.17 B
Mean	5.59	5.74	6.15	5.71	

T_0 = Control **I_0 = 100% of REC. Irrigation (16 Irrigations)**
T_1 = Press-mud **I_1 = 75% of REC. Irrigation (12 Irrigations)**
T_2 = Polymer Coated SSP **I_2 = 50% of REC. Irrigation (8 Irrigations)**
T_3 = 50% Cane Trash boiler ash+50% SOP
HSD value for IR= 0.424

Means not sharing the common letter vary significantly at 5% probability level

Harvest index:

Harvest index is expressed in percentage and defined as the ratio of commercial yield to total biomass yield. The harvest index of the sugarcane crop as affected by different irrigation levels statistically showed (table 9) the significant effect on the harvest index of the sugarcane. The crop plant having I_0 (100% of recommended irrigation) gave maximum harvest index (71.75%), statistically significant with I_1 (75% of recommended irrigation). The effect of soil amendments application was also statistically significant and its range was from 63.51% in T_0 (control) to 67.05% in T_2 (polymer coated SSP) application. The combined influence of levels of irrigation and soil amendments application was also recorded statistically non-significant.

Table 8: Analysis of Variance and effect of different irrigation level and soil applied amendments on harvest index % of sugarcane

A. Comparison of treatment means

Number of irrigations	Organic and Synthetic Supplements				Mean
	T_0	T_1	T_2	T_3	
I_0	70.01	71.97	74.33	70.69	71.75 A
I_1	68.58	68.89	72.17	69.40	69.76 A
I_2	51.94	51.23	54.64	52.69	52.62 B
Mean	63.51 B	64.03 B	67.05 A	64.26 B	

T_0 = Control **I_0 = 100% of REC. Irrigation (16 Irrigations)**
T_1 = Press-mud **I_1 = 75% of REC. Irrigation (12 Irrigations)**
T_2 = Polymer Coated SSP **I_2 = 50% of REC. Irrigation (8 Irrigations)**
T_3 = 50% Cane Trash boiler ash+50% SOP
HSD value for IR: 2.457 **HSD** value for FR: 1.93

Means not sharing the common letter vary significantly at 5% probability level.

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