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Effect of polyhalite as potassium source on growth, yield and quality of sugarcane ratoons under different irrigation regimes

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Abstract
Given that the 82% of sugarcane cultivation in Maharashtra, India occurs in low-rainfall areas with limited surface irrigation access, it is crucial to utilize available water judiciously. Despite potassium-rich soils, its availability to meet sugarcane demands is low, and reliance on imported muriate of potash (MOP) is economically burdensome and potentially harmful to sugar recovery. A field experiment was conducted to evaluate the effects of polyhalite as a potassium source and different drip irrigation regimes on the growth and yield of suru sugarcane ratoons in the inceptisols of MPKV, Rahuri, Maharashtra. The study examined the impact of three drip irrigation levels (100%, 80%, and 60% Etc.) on sugarcane, alongside the potassium sources MOP and Polyhalite combinations. Polyhalite, a multi-nutrient, slow-release mineral containing potassium, calcium, magnesium, and sulfur, was tested as an alternative potassium source. Results showed that irrigation at 100% Etc. regime significantly enhanced nutrient uptake, yield attributes, and sugarcane quality, with comparable results at 80% Etc., suggesting a potential 20% water saving with alternate day drip irrigation at 80% Etc. Potassium application through polyhalite alone or combined with MOP (75:25) significantly improved nutrient uptake, yield attributes, and sugarcane quality.

Keywords: Sugarcane, Potassium, Polyhalite, Drip irrigation, Water use

Introduction

In India, Sugarcane is cultivated in around 50 lakh ha area with production of about 405.42 million tonnes and productivity of 80.11 tonnes ha^{-1} during 2018-19 with highest sugar production of 331.30 lakh tonnes (Anonymous, 2020) [2]. Water stress has a negative impact on sugarcane development and productivity. Sugarcane is a very highwater demanding crop, as an average 10,000-12,000 m^3 of water is required to produce 100 t ha^{-1}. Nevertheless, 82% of sugarcane cultivation falls in regions with low-rainfall where farmers have limited assess to surface irrigation. This indicates that there is need to utilize the available water judiciously (Anonymous, 2020) [2]. Application of water as per crop evapotranspiration demand through drip irrigation system can help to precisely apply water to sugarcane. However, scheduling of irrigation through drip also need to be made precise. There are different approaches to scheduling drip irrigation, one such approach is crop evapotranspiration demand approach. Drip irrigation at 2, 3 and 4-day intervals produced 20, 16 and 13 per cent higher cane yield than furrow irrigation at 75 mm cumulative pan evaporation (CPE) in which the cane yield was 131.4 t ha^{-1} (Singandhupe *et al.*, 2008) [23]. So, there was a need to understand precise level of irrigation required through drip based on crop evapotranspiration demand to save water without reducing the yield significantly.

Similarly, to sustainably cultivate sugarcane second important factor is judicious use of nutrients, as under application may lead to significant yield and quality loss, as well as depleting the soil (Bhatt *et al.*, 2021) [4]. It is estimated that for every 100 tonnes of sugarcane produced, key nutrient requirements are: nitrogen (N) 208 kg ha^{-1}, phosphorus (P) 53 kg ha^{-1}, potassium (K) 280 kg ha^{-1}, sulphur (S) 30 kg ha^{-1}, iron (Fe) 3.4 kg ha^{-1}, manganese (Mn) 1.2 kg ha^{-1} and copper (Cu) 0.6 kg ha^{-1} (Shukla *et al.*, 2009) [22].

While sugarcane K requirements are high (above those of N and P), in practice, little K is applied, even in K-deficient soils (Bhatt *et al.* 2021) [4]. Sugarcane is heavy feeder of Potassium (K). The most important function of K in sugarcane is improvement in cane quality by converting reducing sugars to recoverable sugars. The excess K in plant tissues interferes in sugar process due to scale formation in pans. Its demand may exceed 800 kg/ha. Agronomic value of K rests with increased cane volume, girth and weight per cane, drought and disease resistance and reduced lodging. In rations, K is essential to realize high yield and quality and response was more than for Nitrogen and Phosphorus (Hunsigi, 2011) [12]. Muriate of potash (MOP) is most commonly used and concentrated source of potassium in India to meet potassium nutrition demand of crops (Bhatt and Singh, 2021) [4]. However, MOP contains chlorine and it is claimed in recent researches that it reduces sugar recovery in sugarcane. Watanabe *et al.* (2016) [29] reported that sucrose concentration in sugarcane juice gets affected due to chlorine component of KCl or MOP. As well as nutrient use efficiency of conventional potassic fertilizer (MOP) is also a low due to fixation of potassium in soil and losses with water percolation.

Polyhalite is naturally occurring mineral which contains four out of six major nutrients *viz.*, Potassium, Calcium, Magnesium and Sulphur. Earlier research has concluded positive effect of sulphur and magnesium on growth and yield of sugarcane. Polyhalite as a source of potassium has been gaining recognition in recent years worldwide due to its multi-nutrient, slow-release nature and better results in many crops when compared with MOP (Yermiyahu *et al.*, 2019; Barbarick, 1991) [30, 3]. Ratoons, which frequently provide lower yields than plant cane because modern agricultural practices are not used, occupy more than 50 to 55 per cent of land that is planted with sugarcane in India. Therefore, it is evident that even a slight enhancement in ratoon management techniques would significantly increase total sugarcane yield, quality and sugar recovery (Van Der *et al.*, 2013) [27]. Thus, there was a need to investigate different sources of potassium *viz.* MOP and Polyhalite regarding their effects on growth, yield, quality of sugarcane ratoons and economics of sugarcane ratoons as well as scheduling of drip irrigation at different levels of crop evapotranspiration and interaction between these two factors. An experiment was conducted to test effect of various potassium sources on growth, and yield of suru sugarcane ratoon under different irrigation regimes in inceptisols of MPKV, Rahuri, Maharashtra with objectives to study the effect of irrigation regimes and sources of potassium on growth, yield and quality of sugarcane ratoon I and II.

Materials and Methods

A field experiment was carried out at All India Cordinated Research Project on Irrigation water management, Mahatma Phule Krishi Vidypeeth, Rahuri, during 2020-21 and 2021-22. Experimental plot is geographically situated at $19^0$37' North lattitude and 74 ^{0}64' East longitude. The altitude of experimental site is about 447 m above the mean sea level. Soil was medium deep black and well drained. Topography of land was fairly levelled. Depth of the soil was about 1.5m. Soil samples were taken before starting of experiment on ratoons after the harvest of plant crop in february 2020. Similarly treatment plotwise samples were drawn after harvest of each ratoon from all indiviual plots by making 'v' shape pits to depth of 20 cm. These samples were used to analyse for various soil chemical and physical properties.

The highest mean daily air temperature was recorded was 38.5 ^{0}C during May of month 2020 where as lowest mean daily temperature recorded was 14.2 ^{0}C in the month of December during 2020. Total annual rainfall of 1285mm was recorded during first ratoon with 63 rainy days. Maximum rainfall of about 311.4 mm was received in month of June during first ratoon.

The highest mean daily air temperature recorded was 37.7 ^{0}C in the month of April where as lowest mean daily temperature recorded was 13.7 ^{0}C in the month of January of during 2022.

Total annual rainfall of 940mm was recorded during second ratoon with 53 rainy days. Maximum rainfall of about 246mm in was received in month of September during second ratoon. After removal of plant cane on 1st of February 2020 experimenatal site were laid out into different plots. Transfer of excess trash to bunds was carried out to mark out the plots and buffer zones. Experimental plot was laid out in a split plot design to with three replications.

Experiment consisted of three levels of irrigation regimes as the main plots and sub plots as potassium source levels as follows which made the total treatment combinations of 21.

	Main plot (Irrigation regimes)
I_1	60% Etc.
I_2	80% Etc.
I_3	100% Etc.
	Sub plots (Potassium source levels)
F_1	0% N: 0% P2O5: 0% K2O kg ha^{-1} (Absolute control)
F_2	75% of RDF (K_2O applied through MOP*)* + 10 kg ha^{-1} of Mg and 40 kg ha^{-1} of S
F_3	75% of RDF (K_2O applied through Polyhalite*)*
F_4	100% of RDF (K_2O applied through MOP*)*
F_5	100% of RDF (50% K_2O through MOP + 50% K2O through Polyhalite)
F_6	100% of RDF (25% K_2O through MOP + 75% K2O through Polyhalite)
F_7	100% of RDF (100% K_2O through Polyhalite)

Irrigation was given with drip irrigation layout**,** however fertilizer sources were applied mannualy to keep uniform method of application for both potassium sources *viz.*, MOP and Polyhalite.

Water requirement (Scheduling of irrigation by drip system)

The main (75 mm), sub main (63 mm), manifold (50 mm) and lateral (16 mm) were used for installation of drip system. One lateral was provided for each bed at a spacing of 120 cm with pressure compensating emitters fitted on lateral at 37 cm. The design discharge through emitter was 4 lph with operating pressure maintained 1.20 kg cm^{-2} at control head with the help of control valve. In all, ten emitters were fixed on each lateral. The irrigation water requirement was calculated on alternate day basis by using pan evaporation data and crop factor. The quantity of water applied through emitter and time of operation

of drip unit was estimated by using following standard formula. The depth of water application was calculated using the formula given in FAO paper 36 (Vermerin and Jobling, 1980) [28].
etc. = CPE x Kp x Kc

Where,
etc. = Evapotranspiration of crop (mm) of two days
CPE = Cumulative Pan evaporation of two days (mm)
Kp = Pan factor**,** Kc = Crop factor as per crop growth stage

Sugarcane variety CoM 0265 was selected for experiment with recommended dose of fertilizer 215:115:115 kg ha^{-1} of N, P_2O_5 and K_2O respectively. Conventional fertilizer sources used for experiment were Ure***a*** for nitrogen, DAP for phosphorus and MOP as source of potassium. Mg through $Mgso_4$ and S through elemental sulphur. As source of organic manure, 10 t of FYM was applied after harvest of plant cane to all plots except absolute control F_1.
For recording of observations initialy, five sugarcane plants from each plot were randomly selected, lebelled with pegs and tags and subsequently used for recording biometeric observations**.** During maturity period, the clumps were randomly selected for quality studies viz. brix, pol, purity and CCS (%). Similarly at harvest average cane weight, canes per clump millable canes and cane yield were recorded.
Whole plant of cane from different treatment was collected as sample at harvest time to analyse for nutrient uptake. Collected plants were allowed to air dry first and then oven dried at a temperature of 65^0C in hot air oven. Sample was then broken in to pieces and grounded in mixer and stored in polybags for further chemical analysis. Nitrogen uptake estimation was carried out using concentrated H_2SO_4 is used along with K_2SO_4 and $CuSO_4$, whereas selenium powder was used as catalyst mixture at 20:1 proportion. Plant sample of 0.5g was digested as discribed in procedure given by Jackson (1978) [14]. The sample was then allowed to cool and volume was made upto 100ml with distil water. This sample was then taken to micro-kjeldahl apparaturs, where 10ml of the digested solution was diluted with 10ml of 40 percent NaOH. It liberated ammonia which was collected in solution of 4 percent boric acid mixed with indicators viz., bromocresol green + methyl red. Nitrogen content was estimated by titrating the distillated with 0.02 N H_2SO_4. Phosphorus content was estimated by digesting plant sample with di-acid digestion extract as mentioned by Jackson (1978) [14]. Phosphorus was determined by the vanado-molybdate-yellow colour method. The plant samples were digested with tri-acid mixture $HNO_3 + H_2SO_4 + HClO_4$ digestion (Jackson, 1978) [14] and total K in plant was determined by using flame photometer. Calcium uptake by plant samples were determined by atomic absorption spectrophotometer as suggested by Lindsay and Norvell (1978) [18]. Magnesium uptake by plant samples were determined by magnesium ammonium phosphate method as described by Chapman and Pratt (1961). Sulphur uptake by plant samples were determined by turbidimetric method of Chesnin and Yien (1950) [9].

Total uptake of nutrients (kg ha^{-1})
By multiplying the nutrient uptake in percent with dry matter yield of sugarcane.

$$\text{Uptake of nutrients} = \frac{\text{Nutrient content(\%) x Total dry matter yield (qtl ha}^{-1}\text{)}}{100}$$

Quality parameters of sugarcane juice
Brix (%)
Brix value was recorded with the help of Brix hydrometer. The sugarcane juice was poured in 500 ml measuring cylinder and then freely inserted the brix hydrometer in the cylinder. The brix hydrometer recorded the total soluble solids. Simultaneously, juice temperature was also recorded from brix hydrometer. Then, Schmitz's table was used to correct the recorded values of brix (Spancer and Meade, 1963) [25].

POL (Sucrose %)
About 100 ml of juice was taken in conical flask and 1-2 g lead acetate was added. The contents in conical flask were vigorously stirred. The impurities were filtered off with the help of filter paper. The clear filtrate was taken in polarimeter tube and pol reading was recorded with help of Polarimeter. Then, Schmitz's table was used to calculate the sucrose content of cane juice (Spancer and Meade, 1963) [25].

Purity
The ratio of POL to Brix expressed in percentage defines the purity% of a sample and was determined with the help of formula given below.

$$\text{Purity (\%)} = \frac{\text{POL of stalk juice (\%)}}{\text{Brix of stalk juice (\%)}} \text{ x 100}$$

Commercial cane sugar (CCS%)
Commercial cane sugar percentage in juice was calculated by using the following formula**.** Commercial cane sugar (CCS%)= [S-{ (B-S)0.4}]0.73
Where, S=Sucrose per cent in cane juice**,** B= Corrected brix of cane juice 0.4 and 0.73 are multiplication and crusher factor constants.

Commercial cane sugar yield (t ha^{-1})
The commercial cane sugar at harvest was worked out as follows.

$$\text{CCS (t ha}^{-1}\text{)} = \frac{\text{Commercial cane sugar (\%) x Cane yield (t ha}^{-1}\text{)}}{100}$$

Results and Discussion
Effect of irrigation regimes on nutrient uptake of sugarcane ratoon
The pooled data from 2020-21 (ratoon-I) and 2021-22 (ratoon-II) showed that different irrigation regimes significantly influenced the nutrient uptake of sugarcane, including nitrogen, phosphorus, potassium, sulfur, calcium, and magnesium. The highest nitrogen uptake was observed in the 100% Etc. regime (I_3) with 360.90 kg ha^{-1}, which was on par with the 80% Etc. regime (I_2) at 343.96 kg ha^{-1}, both significantly higher than the 60% Etc. regime (I_1) at 287.04 kg ha^{-1}. Similarly, phosphorus uptake was highest in I_3 at 84.51 kg ha^{-1}, with I_2 recording 80.73 kg ha^{-1}, both outperforming I_1 at 68.48 kg ha^{-1}. Potassium uptake followed the same trend, with I_3 at 531.44 kg ha^{-1}, I_2 at 509.54 kg ha^{-1}, and I_1 at 458.8 kg ha^{-1}. For sulfur, I_3 achieved 34.84 kg ha^{-1}, closely matched by I_2 at 31.28 kg ha^{-1}, while I_1 had 25.84 kg ha^{-1}. Calcium uptake was highest in I_3 at 48.23 kg ha^{-1}, similar to I_2 at 45.41 kg ha^{-1}, and significantly higher than I_1 at 41.18 kg ha^{-1}. Finally, magnesium uptake was 39.9 kg ha^{-1} in I_3, 35.51 kg ha^{-1} in I_2, and lower in I_1 at 24.29 kg ha^{-1}. This indicate

that even after 20% water stress given in I_2 level uptake of nutrients did not reduced significantly. However significantly lower nutrient uptake at harvest of ratoons was recorded in irrigation regime I_1 (60% Etc.). This indicates that at 60 per cent Etc. irrigation regime nutrient uptake got reduced. Shukla *et al.*, 2009 [22] recorded increase in nutrient uptake of N from 156.2 kg ha^{-1} with no irrigation to 163.6 kg ha^{-1} with irrigation. Similarly, Kuchenbuch *et al.* (1986) [16] reported that most +K in the soil is transported to the root surface via diffusion a process highly dependent on soil water.

Effect of various potassium source levels on Nutrient uptake

The pooled data from 2020-21 (ratoon-I) and 2021-22 (ratoon-II) indicated significant variations in nutrient uptake among different potassium sources. Nitrogen uptake was highest with F_7 (RDF N, P + 100% K through Polyhalite) at 402.64 kg ha^{-1}, a 10.46% increase over F_6 (389.2 kg ha^{-1}), a 7.78% increase over F_5 (373.54 kg ha^{-1}), and an 11.57% increase over F_4 (360.89 kg ha^{-1}). F_1, the control, had the lowest uptake at 178.93 kg ha^{-1}, 120% lower than F_7. Phosphorus uptake was also highest in F_7 at 99.35 kg ha^{-1}, showing a 3.7% increase over F_6 (95.80 kg ha^{-1}), a 12.4% increase over F_5 (88.39 kg ha^{-1}), and a 14.0% increase over F_4 (87.11 kg ha^{-1}). F_1 had the lowest uptake at 37.45 kg ha^{-1}, 165% lower than F_7. Potassium uptake in F_7 was 596.04 kg ha^{-1}, a 3.9% increase over F_6 (573.71 kg ha^{-1}), a 7.6% increase over F_5 (554.04 kg ha^{-1}), and an 8.5% increase over F_4 (549.34 kg ha^{-1}). F_1 had the lowest uptake at 247.79 kg ha^{-1}, 141% lower than F_7. Sulfur uptake in F_7 was 43.75 kg ha^{-1}, a 10.8% increase over F_6 (39.48 kg ha^{-1}) and a 23.4% increase over F_5 (35.46 kg ha^{-1}), with F_4 (28.55 kg ha^{-1}) and F_1 (16.99 kg ha^{-1}) showing the lowest uptakes, 53.2% and 157% lower than F_7, respectively. Calcium uptake was highest in F_7 at 53.76 kg ha^{-1}, a 6.2% increase over F_6 (50.63 kg ha^{-1}), a 12.9% increase over F_5 (47.6 kg ha^{-1}), and a 22.3% increase over F_4 (43.97 kg ha^{-1}). F_1 had the lowest uptake at 35.79 kg ha^{-1}, 50.2% lower than F_7. Magnesium uptake was highest in F_7 at 44.36 kg ha^{-1}, a 8.9% increase over F_6 (40.72 kg ha^{-1}), a 20.4% increase over F_5 (36.85 kg ha^{-1}), and a 36.3% increase over F_4 (32.54 kg ha^{-1}). F_1 had the lowest uptake at 18.33 kg ha^{-1}, 142% lower than F_7.

Significantly higher nutrient uptake at harvest of ratoons was recorded in potassium sources level F_7 (RDF N, P + 100% K through Polyhalite). This could be attributed to application of balanced nutrients and recommended dose of nutrients to this treatments which resulted in higher uptake of nutrients. Significantly lower nutrient uptake at harvest of ratoon was recorded in potassium sources level F_1 (0% RDF N, P, K). This could be attributed to lower availability of soil available nitrogen and no addition of fertilizer nitrogen in absolute control plot. Shukla *et al.* (2009) [22] reported that K fertigation enhanced 28.3 per cent N uptake over control. Crop removed greatest amount of Nitrogen 186.9 kg ha^{-1} in plot treated with K compared to no irrigation and K application. Bhatt *et al.* (2021) [4] reported that as K in MOP fixes more strongly to clay particles in the soil than K from polyhalite due to competition between monovalent K^+ and divalant (Ca^{+2}, Mg^{+2}) cations. Udaykumar and Jemila (2016) [26] reported significantly higher calcium uptake at about 82.1 kg ha^{-1} under balanced amount of potassium compared to control which recorded 49 kg ha^{-1} uptake. Cordero *et al.* (1977) [10] reported that availability of calcium to cane increased as a function of increasing levels of potassium fertilization.

Effect of irrigation regimes on yield contributing characters and yield of sugarcane ratoons

Different irrigation regimes had a considerable influence on yield contributing characters *viz.* weight of millable cane plant^{-1}, number millable canes ha^{-1} and yield of sugarcane ratoons. In general, higher number of millable cane 74.22 thousand ha^{-1}, weight of millable cane 1.74 kg plant^{-1} and cane yield 130.13 t ha^{-1} of sugarcane ratoon pooled data were recorded in I_3 (100% Etc.) irrigation regime which remained at par with I_2 (80% Etc.) regime.

However, significantly lower values of number of millable cane 68.02 thousand ha^{-1}, weight of millable cane 1.53 kg plant^{-1} and cane yield 105.28 t ha^{-1} sugarcane ratoon pooled data were recorded in I_1 (60% Etc.) irrigation regime. This indicate that sugarcane ratoons could not grow at their full potential with 40 per cent stressed application of water. This aligns with the findings of Pawar and Bhutkar (2011) [20], who observed that moisture stress led to a reduction in the number of millable canes due to diminished water availability. Further substantiating this, James and Peter (2014) [15] highlighted a direct relationship between soil water usage by crops and cane production, with approximately ten tonnes per hectare of cane being produced for each 100 mm of soil water used. Building upon this understanding, Bhatt *et al.* (2021) [4] reiterated that adequate irrigation levels are vital for achieving higher numbers of millable canes, surpassing the yield obtained under water-stressed conditions. also reported that for higher production assured moisture supply is necessary. Inadequate moisture supply acts as a hindering factor in nutrient uptake and decreases cane yield proportionately.

Effect of potassium sources on yield contributing characters and yield of sugarcane ratoons

Significantly higher number of milliable canes 77.30 thousand ha^{-1}, weight of millable cane 1.82 kg plant^{-1} and cane yield 71.85 t ha^{-1}of ratoon pooled data, was noticed in potassium sources level F_7 than conventional potassium sources level F_4. However, it was at par with level F_6 and F_5 level at these intervals. Significantly lowest values of number of milliable canes 56.25 thousand ha^{-1}, weight of millable cane 1.27 kg plant^{-1} and cane yield 71.85 t ha^{-1}of ratoon I and ratoon II pooled data, were recorded in level F_1 which was absolute control. The study identified a significantly lower number of millable canes per hectare in the control treatment represented by potassium source level F_1 (0% RDF NPK). This reduction was attributed to inadequate nutrition. Moreover, the second ratoon exhibited a slight decrease in the number of millable canes compared to the first ratoon, which was attributed to the higher mortality of established tillers over time. Past research findings from Shukla *et al.* (2009) [22] and Ali *et al.*, (2018) [1] further supported the importance of potassium application in enhancing cane yield through improved tillering and synchronous growth of primary and secondary tillers. Similar results were obtained by Shukla *et al.* (2009) [22] where they found that average cane weight per plant increased from 680 g plant^{-1} at no K application to 796.7 g plant^{-1} at 66 kg K ha^{-1} application.

Effect of irrigation regimes on quality parameters

Different irrigation regimes had a considerable influence on quality parameters of sugarcane ratoons juice quality *viz.*, Brix, POL, CCS% and CCS yield however they could affect much on purity percentage values. Purity percentage values remained at par among all the irrigation regimes during ratoon I and II. Significantly higher values of quality parameters during ratoon I and II *viz.*, Brix(19.77), POL(18.5), CCS (13.50%) and CCS yield (17.63 t ha^{-1}) were recorded in I_3 (100% Etc.) irrigation regime which remained at par with I_2 (80% Etc.) regime.

Significantly lower values of quality parameters during ratoon I and II *viz*., Brix(19.56), POL(18.2), CCS (13.32%) and CCS yield (14.08 t ha^{-1}) were recorded in I_1 (60% Etc.) irrigation regime. The impact of different irrigation regimes on the quality parameters of sugarcane ratoon juice quality was a significant focus of this study. Brix percentage of juice values remained consistent across all irrigation regimes during both ratoon cycles. These findings align with those of Singh and Brar (2015) [24], who similarly observed no significant alterations in sucrose percentage under diverse irrigation schedules. These observations are consistent with the findings of Bhatt *et al.* (2021) [4], who reported higher values of Brix in irrigated treatments compared to water-stressed plots.

Effect of potassium sources levels on quality parameters

Significantly higher Brix percent (19.85), POL (18.7), CCS (%) (13.64) and CCS yield (19.19 t ha^{-1}) was recorded by potassium sources level F_7, however it was at par with level F_6 closely followed by F_5 and conventional potassium sources level F_4. Significantly lowest Brix percent (19.15%), POL (17.4%), CCS% (12.71%) and CCS yield (9.15 t ha^{-1}) was recorded by potassium source level F_1 that is absolute control during ratoon I and II respectively. These findings are consistent with the study by Bhatt *et al.* (2021) [4], which reported enhanced quality parameters of sugarcane, including brix percentage, with increased potassium application. Similar findings were reported by El-Geddawy *et al.* (2015) [11], where increasing doses of applied potassium positively affected brix and sucrose percentages, sugar recovery and the number of millable canes. Additional research conducted by Hunsigi (2011) [13], Kwong (2002) [17], Shukla *et al.* (2009) [22] and Medina *et al.* (2013) [19] consistently highlighted the positive correlation between potassium application and improvements in quality parameters such as brix and polarization (POL).

Table 1: Effect of irrigation regimes and potassium sources on yield contributing characters and yield of sugarcane ratoon pooled data (2020-22)

Tr. No.	Treatment	Pooled data yield & yield contributing characters		
		Millable canes (000 ha^{-1})	Millable cane weight (kg plant^{-1})	Cane yield (t ha^{-1})
I.	**Irrigation regimes (Etc. %)**			
I_1	60%	68.02	1.53	105.28
I_2	80%	73.03	1.70	125.50
I_3	100%	74.22	1.74	130.13
	S.Em. ±	0.47	0.02	1.60
	C.D. at 5%	1.84	0.06	6.30
F.	**Potassium source levels**			
F_1	0% N: 0% P2O5: 0% K2O kg ha-1 (Absolute control)	56.25	1.27	71.85
F_2	75% of RDF (K2O applied through MOP) + 10 kg ha^{-1} of Mg and 40 kg ha^{-1} of S	70.05	1.58	110.97
F_3	75% of RDF (K_2O applied through Polyhalite)	70.57	1.60	113.21
F_4	100% of RDF (K_2O applied through MOP)	75.52	1.75	132.56
F_5	100% of RDF (50% K_2O through MOP + 50% K_2O through Polyhalite)	75.87	1.77	134.59
F_6	100% of RDF (25% K_2O through MOP + 75% K_2O through Polyhalite)	76.74	1.80	138.34
F_7	100% of RDF (100% K_2O through Polyhalite)	77.30	1.82	140.59
	S.Em. ±	1.03	0.02	1.75
	C.D. at 5%	2.95	0.06	5.02
	Interaction (I x F)			
	S.Em. ±	1.78	0.04	3.03
	C.D. at 5%	NS	NS	NS
	General mean	71.76	1.66	120.30

Table 2: Effect of irrigation regimes and potassium sources on quality parameters of sugarcane ratoon pooled data (2020-22)

Tr. No.	Treatment	Quality parameters of sugarcane				
		Brix	POL	Purity	CCS %	CCS yield
I.	**Irrigation regimes (Etc. %)**					
I_1	60%	19.56	18.2	93.53	13.32	14.08
I_2	80%	19.71	18.4	93.79	13.46	16.96
I_3	100%	19.77	18.5	93.80	13.50	17.63
	S.Em. ±	0.02	0.03	0.08	0.02	0.25
	C.D. at 5%	0.07	0.11	NS	0.08	0.97
F.	**Potassium source levels**					
F_1	0% N: 0% P2O5: 0% K2O kg ha-1 (Absolute control)	19.15	17.4	91.28	12.71	9.15
F_2	75% of RDF (K2O applied through MOP) + 10 kg ha^{-1} of Mg and 40 kg ha^{-1} of S	19.70	18.5	94.05	13.49	14.98
F_3	75% of RDF (K2O applied through Polyhalite)	19.72	18.5	94.02	13.50	15.29
F_4	100% of RDF (K2O applied through MOP)	19.74	18.5	93.98	13.51	17.92
F_5	100% of RDF (50% K2O through MOP + 50% K2O through Polyhalite)	19.79	18.6	94.08	13.56	18.26
F_6	100% of RDF (25% K2O through MOP + 75% K2O through Polyhalite)	19.81	18.6	94.19	13.59	18.81
F_7	100% of RDF (100% K2O through Polyhalite)	19.85	18.7	94.35	13.64	19.19
	S.Em. ±	0.02	0.06	0.30	0.04	0.24
	C.D. at 5%	0.06	0.16	0.87	0.12	0.68
	Interaction (I x F)					
	S.Em. ±	0.04	0.10	0.52	0.07	0.41
	C.D. at 5%	0.12	NS	NS	NS	NS
	General mean	19.68	18.4	93.71	13.43	16.23

Table 3: Effect of irrigation regimes and potassium sources on nutrient uptake of sugarcane ratoon pooled data (2020-22)

Tr. No.	Treatment	Nutrient uptake (kg ha^{-1})					
		N	P	K	Ca	Mg	S
I.	**Irrigation regimes (Etc. %)**						
I_1	60%	287.04	68.48	346.49	34.21	19.66	25.85
I_2	80%	343.97	80.74	509.54	45.40	35.51	31.28
I_3	100%	360.91	84.50	531.45	48.24	39.91	34.84
	S.Em. ±	3.27	0.87	5.46	0.44	1.49	0.39
	C.D. at 5%	12.85	3.41	21.46	1.71	5.86	1.52
F.	**Potassium source levels**						
F_1	0% N: 0% P2O5: 0% K2O kg ha^{-1} (Absolute control)	178.93	37.45	247.29	35.80	18.33	17.00
F_2	75% of RDF (K_2O applied through MOP) + 10 kg ha^{-1} of Mg and 40 kg ha^{-1} of S	306.34	70.32	451.88	39.54	31.59	23.64
F_3	75% of RDF (K2O applied through Polyhalite)	302.91	66.91	441.18	43.28	28.26	26.70
F_4	100% of RDF (K2O applied through MOP)	360.90	87.11	549.35	43.97	32.54	28.55
F_5	100% of RDF (50% K2O through MOP + 50% K2O through Polyhalite)	373.54	88.39	554.04	47.60	36.85	35.47
F_6	100% of RDF (25% K2O through MOP + 75% K2O through Polyhalite)	389.20	95.81	573.71	50.63	40.73	39.48
F_7	100% of RDF (100% K2O through Polyhalite)	402.64	99.35	419.99	37.49	33.55	43.75
	S.Em. ±	5.63	1.29	8.05	0.82	1.56	0.51
	C.D. at 5%	16.14	3.69	23.08	2.34	4.47	1.47
	Interaction (I x F)						
	S.Em. ±	9.74	2.23	13.94	1.42	2.70	0.89
	C.D. at 5%	NS	NS	NS	NS	NS	2.67
	General mean	330.64	77.90	462.49	42.62	31.69	30.66

Conclusion

Significantly higher growth, yield and quality attributes sugarcane ratoons are obtained with irrigation regime I_3 (100% Etc.) however results remained at par with 80% irrigation regime. Thus, it is recommended to apply drip irrigation at 80 to 100% Etc. regime. Water saving to the tune of 20 per cent can be achieved by applying drip irrigation on alternate day at 80% of crop evapotranspiration (Etc.) demand in case of water scarcity situation without significant reduction in yield.

Among the potassium sources, application of potassium through Polyhalite alone or in combination with MOP at 75:25 per cent level resulted in significantly higher growth, yield and quality attributes sugarcane ratoons. However, considering higher cost of Polyhalite it is recommended to go for 75:25 or 50:50 per cent combination of Polyhalite and MOP.

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