IMPACT OF SOIL AND FOLIAR APPLICATION OF POTASSIUM ON GROWTH, YIELD OF SUGARCANE AND SUGAR RECOVERY

Nisar Ahmed Soomro[1], Muhammad Siddique Depar[2], Ali Sher Chandio[2], Behari Lal Meghwar[2] and Farman Ali Chandio[3,*]

[1]Social Sciences Research Institute (SSRI), Tandojam,
[2]Arid-Zone Research Institute (AZRI), Umerkot, Pakistan.
[3]Department of Farm Power and Machinery, Faculty of Agricultural Engineering,
Sindh Agriculture University, Tandojam, Pakistan.
NSTRI, Thatta, Sindh, Pakistan.
Corresponding author Farman Ali Chandio email: farman_chandio@yahoo.com, Cell No. 03332732912

ABSTRACT: *In order to investigate the impact of soil and foliar applied K_2O on cane growth, yield and sugar recovery of sugarcane variety Larkana-2004, the experimental trial was carried out during 2012-13 at Sugarcane Section, Agriculture Research Institute, Tandojam. Trial comprised five treatments, M_1=K_2O at 100% Recommended Rate (175 kg ha^{-1} Soil applied at 0 DAS) + 0 foliar spray, M_2=K_2O at 75% of Recommended Rate RR (soil applied) + 1 foliar spray at 75 DAS, M_3=K_2O at 75% RR (soil applied) +2 foliar sprays at 60 & 75 DAS, M_4=K_2O at 50% RR (soil applied) + 1 foliar spray at 75 DAS and M_5=K_2O at 50% RR (soil applied) + 2 foliar sprays at 60 & 75 DAS. The foliar application of potassium was applied at three concentrations i.e. C_1=1% concentration of K_2O as 10g SOP Litre^{-1}, C_2=2% concentration of K_2O as 20g SOP Litre^{-1} and C_3=3% concentration of K_2O as 30g SOP Litre^{-1}. The crop receiving K_2O at 75% RR (soil applied) + 2 foliar sprays at 60 & 75 DAS ranked 1st in all the parameters recorded. The foliar application of K_2O showed that the crop sprayed with K_2O at 3% concentration (30g SOP L^{-1} water) resulted highest values for all traits examined.*

Keywords: Sugarcane, Potassium, K_2O, foliar application, plant growth, cane yield, recovery.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is an important commercial crop in developing and urbanized countries and is a member of Gramineae family [1]. General interest in sugarcane and sugar crops was raised extensively from last few years due to its cost-effective impact on sustainable energy and value added products. Sugarcane improvement programs and better management contributed a maximum increase in sugarcane production in the last three decades and rapid expansion of sugar and amalgamated industries in the developing countries [2].

The average yield ha^{-1} in the country during 2011-12 and 2012-13 was 55.196 and 55.580 tons ha^{-1} respectively [3]. Although, the yield shows an increasing trend, but this yield level is yet lower than the world average (62 tons ha^{-1}) which can be increased by introduction of high yielding varieties and improving crop management [3] and [4]. In Sindh province, during 2011-12 and 2012-13 the area under sugarcane was 245.0 and 254.694 thousand hectares with production of 14455.3 and 15966.2 thousand tons with average yield of 59.00 and 63.00 tons ha^{-1}, respectively. The average yield of Pakistan is well below the world average, while the average cane yield of Sindh province is higher than the world average. The utilization of produced cane in Sindh for the last three years was 97.84, 92.02 and 92.40 percent which reflects a promising situation in relation to cane production and its proper utilization in the province [3].

There are many factors which influence the cane yield and predominantly poor agricultural practices, stresses like water and nutrients management and low cane yielding varieties which cause a significant loss in total yield [2]. However, balanced fertilizer application, a part of better management has important role in sugarcane production; because sugarcane is a heavy feeder crop and requires well managed scheduling of fertilizer application than any other field crop and appropriate method of fertilizer application improves the efficient use of the fertilizers [5].

Potassium (K) plays fundamental part in photosynthesis, translocation of photosynthates, protein manufacturing, ion balancing, correct use of water, stomata regulation, enzymes activation and many other internal plant functions [6]. Potassium is one of the most abundant nutrient elements in soil and one that is required in large amounts by plants. Of the huge amount of K in many soils only a function is available for immediate uptake by plants in the large term, and in the absence of any added K, the vulnerability of crop production to K availability is mainly related to the amount and rate of release of K from soil minerals [7]. 150 kg K_2O ha^{-1} foliar application @ 2.50% concentration proved better in achieving reasonable sugarcane yield, optimal nutrient uptake under drought situations [8].

In Pakistan, use of K is very low which is around 0.73 kg ha^{-1} as against 85 kg of nitrogen and 21 kg of P_2O_5 which seems to be inadequate and imbalanced to explore the production potential of the crop [9]. Pakistan soils have developed from micaceous alluvium and the irrigation water has high K contents, the crop is well supplied with the element. So it is generally presumed that crops will not positively respond to K and only N and P are applied. However, with the introduction of high yielding varieties and intensive agronomic practices sugarcane crop is becoming more responsive to higher K levels than recommended rates. A little research work has been done regarding K application time as it is often applied at sowing and that too in small quantity [9] and [10].

Foliar fertilizers containing different macro and micronutrients are being applied for field crops. Foliar fertilizing is the exercise of using liquid fertilizers to plants particularly leaves [11], which play essential role in regulating the crop growth [12]. Foliar fertigation quickly transport nutrients to the needy tissues and organs of the plant. The leaves of the plants are factories where photosynthesis takes place and produces compounds which are important for plant growth. These liquid fertilizers are absorbed as they applied and acting fast. It was proved that up to 80 percent of the

foliar applied potassium is sucked up directly whereas 80 percent of the potassium applied conventional may get fixed up in the soil [13]. The present study was conducted to investigate the impact of soil and foliar applied K_2O on cane growth, yield and sugar recovery of sugarcane variety Larkana-2004.

MATERIALS AND METHODS

The experiment trial was designed at the field of Sugarcane Section, Agriculture Research Institute, Tandojam. Experiment was conducted during 2011 in three replications with factorial arrangements having plot size of 5m x 3m (15 m^2) in Randomized Complete Block Design. The seed setts were placed end-to-end method in ridges. Seedbed was prepared adopting recommended land preparation practices. The planting was done by dry method by end-to-end placement of seed setts. The planting was completed on 11.10.2011. The nursery cane seed about eight months age was obtained and used, upper two third portion of stalk of the fresh cane of sugarcane plant was used. Before planting seed setts were treated with Vitavax @ 120 g/100 litre of water to protect against seed borne sugarcane diseases i.e., whip smut. Initially, light irrigations were applied from October to December and later heavy flooding was offered. During hot summer days irrigation must be applied at 7-10 days interval i.e., during April-August and during winter i.e., from November-March irrigation may be applied at 10-15 days interval, due to severe irrigation water shortage conditions tube well water may be applied. N-P fertilizers were conventionally applied at the rates of 287-145 kg ha^{-1} respectively where Potassium was applied as per the treatment plan by foliar in five methods i.e., M_1= K_2O at 100% recommended rate: 175kg ha^{-1} (soil applied at 0 DAS) + 0 Spray, M_2 = K_2O at 75% recommended rate: (soil applied) + 1 Foliar Spray at 75 DAS, M_3 = K_2O at 75% recommended rate: (soil applied) + 2 Foliar Spray at 60 &75 DAS, M_4 = K_2O at 50% recommended rate: (soil applied) + 1 Foliar Spray at 75 DAS and M_5 = K_2O at 50% recommended rate: (soil applied) + 2 Foliar Spray at 60 & 75 DAS. With three concentrations i.e., C_1=1% K_2O, C_2=2% K_2O andC_3=3% K_2O. All P and K and 1/3rd of N were used during plantation where remaining N was used in two equal parts at first earthing (about three and half months after plantation) and second part after first earthing (about one and half month after first earthing) respectively. A comprehensive approach of I.P.M consisting of cultural, biological and chemical method of control of insect pests and diseases was adopted to maintain the pest population level below the economic injury level. However Furadan 3G was applied against the borers. The harvesting of trial was done when the about $^1/_3$ leaves of the lower portion of the stalk of cane were dry and showed propensity of dropping on the soil. Technically, the crop matures when the brix reading is above 20% irrespective of any variety.

Methods for recording observations

1. **Cane length:** With the help of measuring tape length was recorded from base of the stalk of cane up to the last internode from ten randomly selected labelled sugarcane plants in centimetres and averaged.
2. **Cane girth:** With the help of Vernier Calliper cane girth was measured from randomly selected (tagged) plants in each plot in centimetres and averaged.
3. **Tillers stool^{-1}:** It was recorded by counting the sprouted stalks of each plant from randomly selected and labelled in each plot and average was calculated.
4. **Internodes cane^{-1}:** Internodes were also counted from the base of the stalk of cane up to the last internode from labelled plants in each plot and averaged.
5. **Weight of 10 canes (kg):** For weighing randomly selected (tagged) plants were harvested and weighed with field balance; quantity was recorded in kilograms and averaged. These canes were also used for crushing and further juice analysis.
6. **Cane yield ha^{-1}(mt):** The cane yield ha^{-1} was calculated with following formula:

$$\text{Cane yield (mt ha}^{-1}) = \frac{\text{Yield plot}^{-1} \text{ of given treatment}}{\text{Plot area (m}^2)} \text{ X } 10000$$

7. **Sugar recovery (%): It was calculated as** procedure and method described in laboratory manual for Queensland sugar mills Anonymous [14] for Polarity and sugar recovery. The recorded data of described traits were collected and statistically analysed. Analysis of variance and mean separation tests were applied after Gomez and Gomez [15].

RESULTS AND DISCUSSION

Potassium is among the nutrient elements essentially required for plant growth, yield and sugar recovery in sugarcane crop. The study showed the effect of K_2O application (soil applied) methods and foliar applied K_2O concentrations on all the growth and cane yield traits as well as on sugar recovery of variety Larkana-2004 was significant ($P<0.05$). Sugarcane variety Larkana-2004 showed markedly high performance when the crop was supplied with K_2O at 75% recommended rate (soil applied) + 2 foliar sprays at 3% K_2O concentration (30g SOP L^{-1} water). This treatment interaction resulted in significantly highest cane yield and sugar recovery; while replacing 50% K_2O for foliar spray could not compensate positively and adverse effects on the growth, cane yield and recovery were noticed. This treatment interaction resulted in significantly highest cane yield and sugar recovery; while replacing 50% K_2O (soil applied) by foliar spray could not compensate well and negative effect on crop performance was noticed.

Cane length (cm)

The cane length was maximum (252.44 cm) in plots supplied with K_2O at 75% recommended rate + 2 foliar sprays of K at 60 and 75 days after sowing, followed by average cane length of 248.56 cm and 248.33 cm observed in plots supplied with soil applied K_2O at 100% recommended rate (175 kg ha^{-1}) and K_2O at 75% recommended rate + 1 foliar spray of K at 75 days after sowing, respectively (Table 1). The cane length reduced to 230.56 cm when the crop was supplied with K_2O at 50% recommended rate (soil applied) + 2 foliar sprays of K at 60 and 75 days after sowing; while the lowest cane length of 225.56 cm was observed in plots supplied with K_2O at 50% recommended rate (soil applied) + 1 foliar spray of K at 75 days after sowing. In case of concentrations for foliar K-application, the sugarcane crop sprayed with 3% K_2O concentration (30g SOP L^{-1} water) resulted in maximum cane length of 246.80 cm, followed by 241.93 cm cane length in 2% concentration (20g SOP L^{-1} water), whereas the lowest cane length of 234.53 cm was observed in plots given foliar

Table 1. Cane length (cm), cane girth (cm), Tillers stool^{-1} and Internodes cane^{-1} of sugarcane variety Larkana-2004 as affected by application methods of soil applied K and concentration of foliar applied K.

	Cane length (cm)				Cane girth (cm)				Tillers stool^{-1}				Internodes cane^{-1}			
K-Application methods	**K-concentrations**			**Mean**	**K-concentrations**			**Mean**	**K-concentrations**			**Mean**	**K-concentrations**			**Mean**
	C_1	**C_2**	**C_3**		**C_1**	**C_2**	**C_3**		**C_1**	**C_2**	**C_3**		**C_1**	**C_2**	**C_3**	
M_1	241.67	249.33	254.67	248.56 b	2.90	3.00	3.06	2.99 b	4.92	5.10	5.20	5.07 b	16.25	16.83	17.17	16.75 b
M_2	241.33	249.33	254.33	248.33 b	2.90	3.00	3.05	2.98 b	4.92	5.09	5.18	5.06 b	16.25	16.81	17.11	16.72 b
M_3	245.67	253.33	258.33	252.44 a	2.95	3.04	3.11	3.03 a	5.01	5.16	5.79	5.32 a	16.53	17.05	18.02	17.20 a
M_4	219.33	226.33	231.00	225.56 d	2.68	2.71	2.77	2.72 d	4.56	4.61	4.71	4.63 d	15.05	15.22	15.56	15.28 d
M_5	224.67	231.33	235.67	230.56 c	2.70	2.77	2.83	2.77 c	4.59	4.70	4.80	4.70 c	15.15	15.52	15.85	15.51 c
Mean	**234.53 c**	**241.93 b**	**246.80 a**	**-**	**2.82 c**	**2.90 b**	**2.96 a**	**-**	**4.80 c**	**4.93 b**	**5.14 a**	**-**	**15.85 c**	**16.28 b**	**16.74 a**	

Different letters within a row indicate significant difference (P< 0.05)

Table 2. Weight of 10 canes (kg), Cane yield (tons ha^{-1}) and Sugar recovery (%) of sugarcane variety Larkana-2004 as affected by application methods of soil applied K and concentration of foliar applied K.

	Weight of 10 canes (kg)				Cane yield (tons ha^{-1})				Sugar recovery (%)			
K-Application methods	**K-concentrations**			**Mean**	**K-concentrations**			**Mean**	**K-concentrations**			**Mean**
	C_1	**C_2**	**C_3**		**C_1**	**C_2**	**C_3**		**C_1**	**C_2**	**C_3**	
M_1	14.29	14.79	15.09	14.72 b	85.660	88.640	90.260	88.187 b	10.04	10.41	10.62	10.36 b
M_2	14.28	14.77	15.04	14.70 b	85.263	88.740	90.540	88.181 b	10.05	10.39	10.58	10.34 b
M_3	14.53	14.99	16.79	15.44 a	87.180	89.920	98.496	91.865 a	10.22	10.54	11.35	10.71 a
M_4	13.23	13.38	13.68	13.43 c	79.400	80.280	80.692	80.124 d	9.71	9.91	9.94	9.85 c
M_5	13.31	13.65	13.93	13.63 c	79.860	81.900	82.187	81.316 c	9.90	9.84	9.85	9.86 c
Mean	**13.93 c**	**14.32 b**	**14.91 a**	**-**	**83.473 c**	**85.896 b**	**88.435 a**	**-**	**9.98 c**	**10.22 b**	**10.47 a**	**-**

Different letters within a row indicate significant difference (P< 0.05)

K_2O at 1% concentration (10g SOP L^{-1} water). The interactive effect (Fig. 1) indicated that interaction of K_2O at 75% recommended rate (soil applied) + 2 foliar sprays × 3% concentration of K_2O (30g SOP L^{-1} water) resulted in maximum cane length of 258.33 cm, while the lowest cane length (219.33 cm) was observed in the interaction of K_2O at 50% recommended rate (soil applied) + 1 foliar spray × 1% concentration of K_2O (10g SOP L^{-1} water). These findings are in line with the studies conducted by Ghaffar, *et. al*. [10], Ramesh and Varghese [16] and Cakmak [17] found that 168 kg potassium in two parts; half at sowing time + half portion after 90 days of sowing produce maximum cane stalk length. Bokhtiar, *et. al*. [18] recorded higher stalk height (3.83 m) on 150N-50P-95K-34S-3.5Zn kg ha^{-1} plus 10 mt ha^{-1} Cow Dung (K was 75%).

Cane girth (cm)

The cane girth was maximum (3.03 cm) when K_2O was applied at 75% recommended rate (soil applied) + 2 foliar sprays of K_2O at 60 and 75 days after sowing (DAS), followed by cane girth of 2.99 and 2.98 cm in plots given K_2O at 100% recommended rate (175 kg ha^{-1}) + 0 foliar K_2O and K_2O at 75% recommended rate + 1 foliar spray of K_2O at 75 DAS, respectively (Table 1). The cane girth reduced to 2.77 cm in plots given K_2O at 50% recommended rate (soil applied) + 2 K_2O foliar sprays at 60 and 75 DAS; whereas the lowest cane girth of 2.72 cm was found in plots given K_2O at 50% recommended rate (soil applied) + 1 foliar spray of K_2O at 75 DAS. In case of foliar applied K_2O concentrations, the crop sprayed with 3% K_2O (30g SOP L^{-1} water) resulted in maximum cane girth of 2.96 cm, followed by 2.90 cm cane girth in 2% K_2O concentration (20g SOP L^{-1} water), where the lowest cane girth of 2.82 cm was noted in those plot in which foliar K_2O at 1% concentration (10g SOP L^{-1} water) was given. The interactive effect (Fig. 2) showed that interaction of K_2O at 75% recommended rate (soil applied) + 2 foliar sprays × 3% concentration of K_2O (30g SOP L^{-1} water) resulted in maximum cane girth of 3.11 cm, however the minimum cane girth (2.68 cm) was noted in the interaction of K_2O at 50% recommended rate (soil applied) + 1 foliar spray × 1% concentration of K_2O (10g SOP L^{-1} water). These results are in confirmation with those of Bokhtiar, *et. al.*, [18] indicated that higher stem thickness/girth (2.28 cm) achieved if potassium treatment, 150N-50P-127K-34S-3.5 Zn kg ha^{-1} were applied. Ashraf *et. al*, [19] also found that the cane diameter was more in the plants treated with K and N under saline conditions. Same results also Khosa [20] observed that increasing rates of K fertilizer increases cane diameter.

Tillers $stool^{-1}$

Maximum tillers $stool^{-1}$ (5.32) were recorded in plots given K_2O at 75% recommended rate (soil applied) + 2 foliar sprays of K_2O at 60 and 75 DAS, followed by 5.07 and 5.06 tillers $stool^{-1}$ observed in plots given soil applied K_2O at 100% recommended rate (175 kg ha^{-1}) + 0 foliar K_2O and K_2O at 75% recommended rate + 1 foliar spray of K_2O at 75 DAS, respectively (Table 1). The tillers $stool^{-1}$ decreased to 4.70 in plots given K_2O at 50% recommended rate (soil applied) + 2 K_2O foliar sprays at 60 and 75 DAS; however the lowest no. of tillers $stool^{-1}$ 4.63 was noted in plots given K_2O at 50% recommended rate (soil applied) + 1 foliar K_2O spray at 75 DAS. The effect of foliar applied K_2O indicated that 3% K_2O (30g SOP L^{-1} water) resulted in maximum tillers $stool^{-1}$ (5.14), followed by 4.93 tillers $stool^{-1}$ in 2% K_2O concentration (20g SOP L^{-1} water), whereas the lowest tillers $stool^{-1}$ (4.80) was observed in plots given foliar K_2O at 1% concentration (10g SOP L^{-1} water). The interactive effect (Fig. 3) indicated that interaction of K_2O at 75% recommended rate (soil applied) + 2 foliar sprays × 3% concentration of K_2O (30g SOP L^{-1} water) resulted in maximum tillers $stool^{-1}$ (5.79), where the minimum tillers $stool^{-1}$ (4.56) was observed in the interaction of K_2O (soil applied) at 50% recommended rate + 1 foliar spray × 1% concentration of K_2O (10g SOP L^{-1} water). Sarwar *et. al.* [21] observed maximum tillers on combination of solid and liquid fertilizers along the liquid K fertilizer spray which results were at par with standard dose of solid fertilizers. Ashraf, *et al*. [19] also indicated that number of tillers per plant was increased with the use of nitrogen and optimal levels of potassium fertilizers.

Internodes $cane^{-1}$

The maximum internodes $cane^{-1}$ (17.20) were observed in plots given K_2O (soil applied) at 75% recommended rate + 2 foliar sprays of K_2O at 60 and 75 DAS, followed by 16.75 and 16.72 internodes $cane^{-1}$ observed in plots given soil applied K_2O at 100% recommended rate (175 kg ha^{-1}) + 0 foliar K_2O and K_2O (soil applied) at 75% recommended rate + 1 foliar spray of K_2O at 75 DAS, respectively (Table 1). The internodes $cane^{-1}$ diminished to 15.51 in plots given K_2O (soil applied) at 50% recommended rate + 2 foliar sprays of K_2O at 60 and 75 DAS; while the minimum internodes $cane^{-1}$ (15.28) were found in plots given K_2O (soil applied) at 50% recommended rate + 1 foliar spray of K_2O at 75 DAS. The effect of foliar applied K_2O concentrations showed that 3% K_2O (30g SOP L^{-1} water) resulted in highest internodes $cane^{-1}$ (16.74), followed by 16.28 internodes $cane^{-1}$ in 2% K_2O concentration (20g SOP L^{-1} water), while the minimum internodes $cane^{-1}$ (15.85) was observed in plots given foliar K_2O at 1% concentration (10g SOP L^{-1} water). The interactive effect (Fig. 4) showed that interaction of K_2O (soil applied) at 75% recommended rate + 2 foliar sprays × 3% concentration of K_2O (30g SOP L^{-1} water) resulted in maximum internodes $cane^{-1}$ (18.02), while the minimum internodes $cane^{-1}$ (15.05) were noted in the interaction of K_2O (soil applied) at 50% recommended rate + 1 foliar spray × 1% concentration of K_2O (10g SOP L^{-1} water). Khosa [20] indicated that as rates of K fertilizer increased length of internodes also increased. Similarly Shahid, *et. al*. [22] showed that more number of internodes was obtained from the crop when treated with Biocane 2.5 l ha^{-1} + N: P: K -17 0:8 5:8 5 kg ha^{-1}.

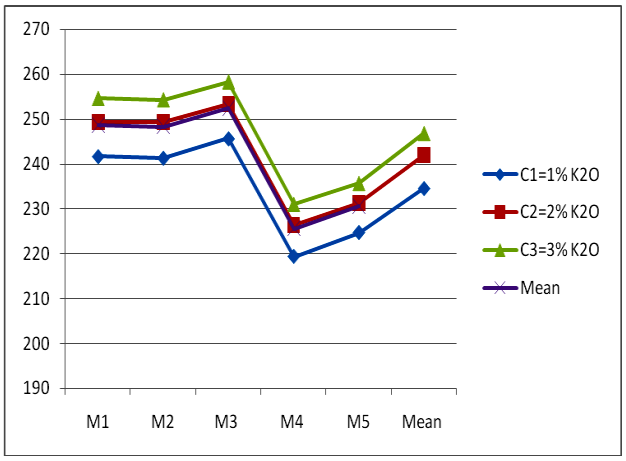

Fig. 1, Cane length (cm)

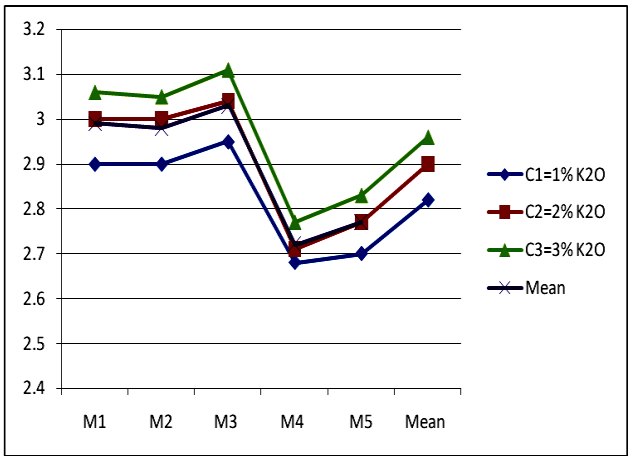

Fig. 2, Cane girth (cm)

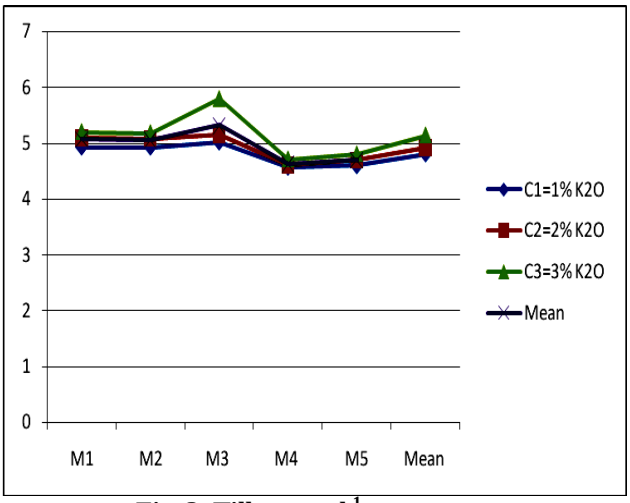

Fig. 3, Tillers stool^{-1}

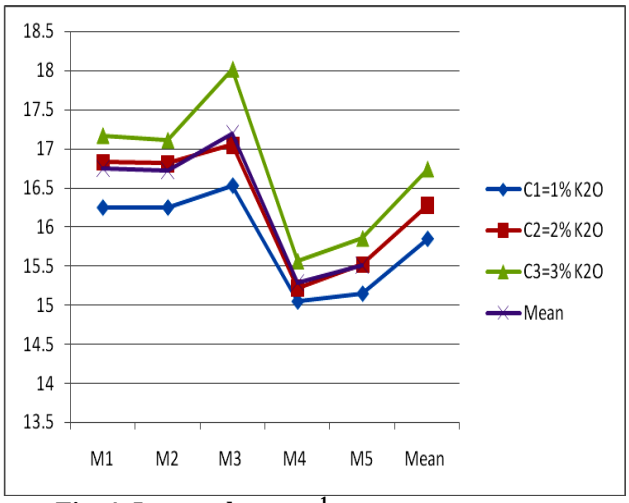

Fig. 4, Internodes cane^{-1}

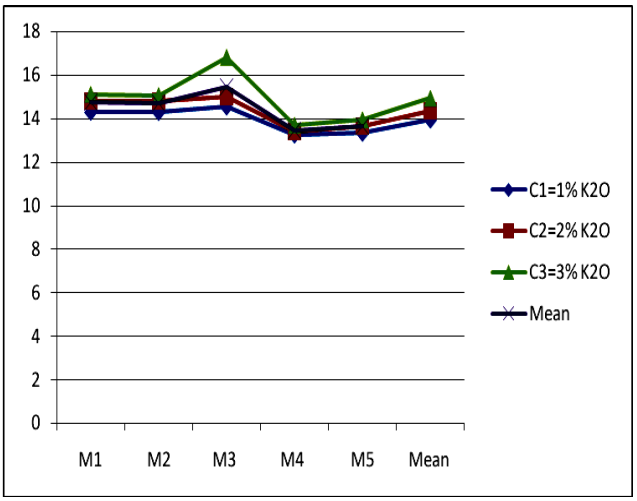

Fig. 5, Weight of 10 canes (kg)

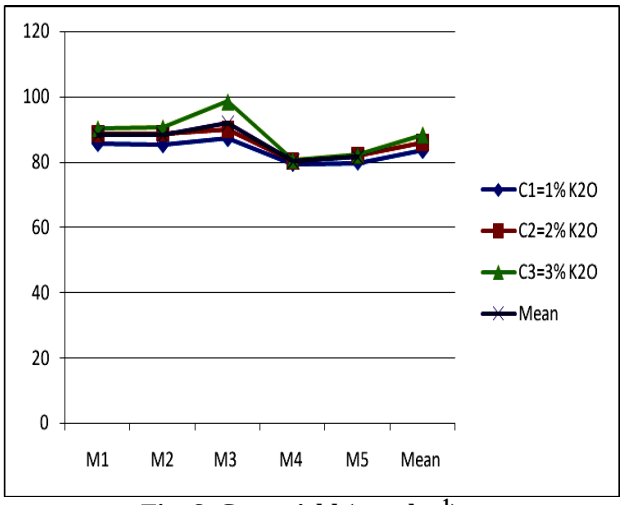

Fig. 6, Cane yield (tons ha^{-1})

Weight of 10 canes (kg)

Highest weight of 10 canes (15.44 kg) was noted in plots given K_2O (soil applied) at 75% recommended rate + 2 foliar sprays of K_2O at 60 and 75 DAS, followed by 14.72 and 14.70 kg weight of 10 canes found in plots given soil applied K_2O at 100% recommended rate (175 kg ha^{-1}) + 0 foliar K_2O and K_2O (soil applied) at 75% recommended rate + 1 foliar spray of K_2O at 75 DAS, respectively. The weight of 10 canes declined to 13.63 kg in plots given K_2O (soil applied) at 50% recommended rate + 2 foliar sprays of K_2O at 60 and 75 DAS; while the minimum weight of 10 canes (13.43 kg) was noted in plots given K_2O (soil applied) at 50% recommended rate + 1 foliar spray of K_2O at 75 DAS (Table 2). The effect K_2O concentrations indicated that 3% K_2O (30g SOP L^{-1} water) produced highest weight of 10 canes (14.91 kg), followed by 14.32 kg weight of 10 canes in 2% K_2O concentration (20g SOP L^{-1} water), while the lowest weight of 10 canes (13.93 kg) was noted in plots given foliar K_2O at 1% concentration (10g SOP L^{-1} water). The data further showed that interaction (Fig. 5) of K_2O (soil applied) at 75% recommended rate + 2 foliar sprays × 3% concentration of K_2O (30g SOP L^{-1} water) produced highest weight of 10 canes (16.79 kg), and minimum weight of 10 canes (13.23 kg) was resulted by the interaction of K_2O (soil applied) at 50% recommended rate + 1 foliar spray × 1% concentration of K_2O (10g SOP L^{-1} water). Khosa, [20] describe his results that increasing rates of K fertilizer increased number of millable canes per unit area. Shahid *et. al*. [22] observed that the highest weight of stripped cane (0.8 7 kg) and trash weight (8.4 2 tha^{-1}) were achieved in the treatment where, biocane 2.5 l ha-1 + N: P: K -17 0:8 5:8 5 kg ha^{-1} was applied.

Cane yield (tons ha^{-1})

Cane yield was highest (91.865 tons ha^{-1}) in plots given K_2O (soil applied) at 75% recommended rate + 2 foliar sprays of K_2O at 60 and 75 DAS, followed by cane yield of 88.187 and 88.181 tons ha^{-1} observed in plots given soil applied K_2O at 100% recommended rate (175 kg ha^{-1}) + 0 foliar K_2O and K_2O (soil applied) at 75% recommended rate + 1 foliar spray of K_2O at 75 DAS, respectively (Table 2). The cane yield reduced considerably to 81.316 tons ha^{-1} in plots given K_2O (soil applied) at 50% recommended rate + 2 foliar sprays of K_2O at 60 and 75 DAS; while the minimum cane yield (80.124 tons ha^{-1}) was observed in plots given K_2O (soil applied) at 50% recommended rate + 1 foliar spray of K_2O at 75 DAS. The effect of K_2O concentrations showed that 3% K_2O (30g SOP L^{-1} water) produced highest cane yield (88.435 tons ha^{-1}), followed by cane yield of 85.896 tons ha^{-1} in 2% K_2O concentration (20g SOP L^{-1} water), while the lowest cane yield (83.473 tons ha^{-1}) was resulted by foliar K_2O at 1% concentration (10g SOP L^{-1} water). The interaction (Fig. 6) of K_2O (soil applied) at 75% recommended rate + 2 foliar sprays × 3% concentration of K_2O (30g SOP L^{-1} water) resulted in highest cane yield (98.496 tons ha^{-1}), and minimum cane yield (79.40 tons ha^{-1}) was noted in interaction of K_2O (soil applied) at 50% recommended rate + 1 foliar spray × 1% concentration of K_2O (10g SOP L^{-1} water). The results are supported by Ramesh and Varghese [16] who reported that the cane yield increased from 50 to 74.5 t ha^{-1} with application of potassium from 0 to 60 kg ha^{-1}. Mathew, *et al.*, [23] revealed his results and stated that application of 75% potassium in soil as basal of recommended dose with 25% applied as foliar, increases millable cane and cane yield. Bokhtiar, et. al., [18] observed 25.4 % highest cane yield of 126.3 mt ha^{-1} on the treatment (T2) of Potassium (127 kg ha^{-1}) fertilizer was applied. Ashraf, *et al.* [19] found that application of potassium through soil at the rate of 150 kg K_2O ha^{-1} and foliar application of @ 2.50% concentration proved to be effective in achieving economical sugarcane yield. Lin, *et al.* [24] elucidated that combined application of nitrogen, phosphorus and potassium may affect optimistically on sugarcane yield and yield attributing components.

Sugar recovery (%)

The sugar recovery was maximum (10.70%) when the crop was given K_2O at 75% recommended rate (soil applied) + 2 foliar sprays of K_2O at 60 and 75 DAS, followed by 10.36 and 10.34% recovery observed in plots given K_2O at 100% recommended rate (175 kg ha^{-1}) + 0 foliar K_2O and K_2O at 75% recommended rate + 1 foliar spray of K_2O at 75 DAS, respectively. The sugar recovery followed an adverse trend and decreased to 9.86% in crop given K_2O at 50% recommended rate (soil applied) + 2 K_2O foliar sprays at 60 and 75 DAS; whereas the nominal sugar recovery of 9.85% was indicated in plots given K_2O at 50% recommended rate (soil applied) + 1 foliar spray of K_2O at 75 DAS (Table 1). It was further noted that the crop sprayed with 3% K_2O (30g SOP L^{-1} water) resulted in highest sugar recovery of 10.47%, followed by 10.22% recovery when K_2O was applied at 2% concentration (20g SOP L^{-1} water), while the lowest recovery of 9.98% was noted in crop given foliar K_2O at 1% concentration (10g SOP L^{-1} water). The interaction (Fig. 7) of K_2O at 75% recommended rate (soil applied) + 2 foliar sprays × 3% concentration of K_2O (30g SOP L^{-1} water) obtained in maximum sugar recovery of 11.35%, where the lowest sugar recovery (9.71%) was determined in interaction of K_2O at 50% recommended rate (soil applied) + 1 foliar spray × 1% concentration of K_2O (10g SOP L^{-1} water). Similarly, Tahir *et al*. [25] indicated that potassium nutrition has a positive effect on both growth and sugar production. Khosa [20] found that higher 16.5% sucrose was obtained when treated with 200 kg K_2O/ha, where Sarwar *et. al.*, [21] recorded maximum sugar recovery on control 0 press mud and 168-112-112 NPK kg ha^{-1} rather than liquid and solid fertigation.

CONCLUSIONS

It was concluded that sugarcane variety Larkana-2004 showed markedly high performance when the crop was supplied with K_2O at 75% recommended rate (soil applied) + 2 foliar sprays at 3% K_2O concentration (30g SOP L^{-1} water). This treatment interaction resulted in significantly highest cane yield and sugar recovery; while replacing 50% K_2O for foliar spray could not compensate positively and adverse effects on the growth, cane yield and recovery were noticed.

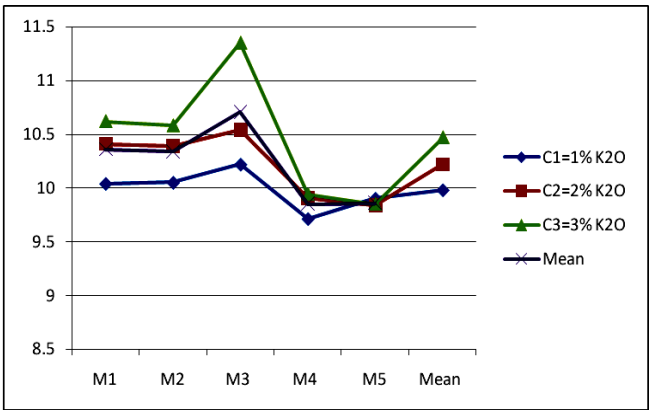

Fig. 7, Sugar recovery

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