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Response of sugarcane varieties to different levels of phosphorus application on yield and quality parameters of sugarcane under south Gujarat condition

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Abstract
A field experiment was conducted at college Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat)to study the response of sugarcane varieties to phosphorus levels under South Gujarat conditions for two years during 2015-16 and 2016-17 on clay soils. In all 16 treatments combinations arising out of four variety *i.e.,* V1 = Co 86002, V_2 = Co 86032, V_3 = Co N 5071 and V_4 = Co N 7072 and four levels of phosphorus *i.e.,* P_0 = control, P_1 = 50, P_2 = 100 and P_3 = 150 kg/ha P_2O_5 were tested in factorial RBD. In case of number of millable cane and millable cane yield treatment V_4 and V_3 remained at par with each other and both recorded significantly higher number of millable cane and millable cane yield in comparison to treatment $V_1$and V_2, while in quality parameters treatment V_2 and V_3 showed their superiority over treatment V_1 and V_4 over respect to most of the quality parameters of sugarcane. Application of 150 kg/ha P_2O_5 (P_3) noted significantly higher number of millable cane and millable cane yield as well as quality parameters of sugarcane *viz*., commercial cane sugar yield (t/ha) and P and K content in juice (ppm). Interaction effect of different variety of sugarcane and different levels of phosphorus application that treatment combination of V_4P_3 (Co N 7072 and 150 kg/ha P_2O_5) recorded significantly higher number of millable cane per hectare and millable cane yield.

Keywords: Sugarcane, Phosphorus, Variety, Millable cane yield, Quality parameters

Introduction
Sugarcane (*Saccharum officinarum* L.) is one of the important cash crops in India which plays a crucial role in national economy of the country, while sugar industry is the second largest agro- industry next to textile and is a source of food, fuel, fodder and fiber. Sugarcane is the main sugar producing crop that contributes nearly 75% to the total pool at the global level, the rest being contributed by beet sugar and other source. Across the world 70% sugar is manufactured from sugarcane (Yadav and Solomon, 2006) [11]. Phosphorus plays a vital role in the formation of protoplasm and in the function of nucleus including the chromosomes. It has a vital role in enzymes and energy transformation. It promotes root growth and stimulates sprouting of buds and tillering. P encourages sugar accumulation and also helps in clarification of juice in the mill. For better clarification the juice phosphorus content must be above 360 ppm (Perumal, 1986) [6]. Phosphorus plays an important role in energy exchange and its deficiency retards growth, tillering, width of leaf blade, girth and length of internodes. Phosphorus at early growth period helps in for sprouting and for early establishment of crop through extensive root system and vigorous growth of shoots. In order to generate information regarding phosphorus requirement for sugarcane varieties under South Gujarat conditions.

Material and Methods
A field experiment was conducted at college Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat)for two consecutive years during 2015-16 and 2016-17 to study the response of sugarcane varieties to phosphorus levels under South Gujarat conditions. The soil of the experimental plot was clayey in texture with low in organic carbon (0.42 % and 0.44 %), low in available nitrogen (213.00 kg/ha and 221.00 kg/ha), low in available phosphorus (9.12 kg/ha and 14.19 kg/ha), low in available potassium (289.00 kg/ha and 285.00 kg/ha) and slightly alkaline in reaction (pH 8.41 and 8.33) during 2015-16 and

2016-17, respectively. In all 16 treatment combinations arising out of four variety (V_1 = Co 86002, V_2 = Co 86032, V_3 = Co N 5071 and V_4 = Co N 7072) and four levels of phosphorus (P_0 = control, P_1 = 50, P_2 = 100 and P_3 = 150 kg/ha P_2O_5) were tested in Factorial RBD with three replications. Total recommended dose of fertilizer was 250 – 125 – 125 NPK (kg/ha). The total quantity of K in form of MOP and P in form of SSP as per the treatments was given as basal dose as well as N in form of urea was applied in four splits in plant sugarcane crop (15 % at time of planting, 30% at 45 days after planting, 20 % at 90 DAP and 35 % at before final earthing up). The sugarcane was sown in the 5th January during first year and 13th February during second years. Five plants from net plot area of each treatment were randomly selected and tagged for recording observations on yield and quality parameters. Millable cane yield were recorded from net plot area of the each treatment and used for determining the quality parameters. The selected cane samples were cut in to 45 to 50 cm length, weighed and juice was extracted using mechanical crusher. The juice was collected in previously weighed bucket containing 0.5 g $HgCl_2$ as preservative and used for further analysis of quality parameters. The experimental data collected during the course of investigation were statistically analyzed as per the procedure given by Dhama and Ramamoorthy (2008) [3].

Results and discussion

Effect of variety

Number of millable cane and millable cane yield

In order to quantify the response observed due to different variety of sugarcane on number of millable cane and millable cane yield was assessed on pooled basis. From Table-1 treatment V_4 (Co N 7072) variety obtained significantly highest number of millable canes per hectare (85113) and millable cane yield (88.93 t/ha) at harvest which was statistically at par with Co N 5071 (V_3).This result may be due to the genetic differences among varieties in their ability of formation of yield attributes parameters. These results are similar with those obtained by Shukla (2007) [8], Srivastava *et. al.* (2007) [10] and Shukla and Singh (2011) [9].

Quality parameters

The data on quality parameters of sugarcane *viz*., brix (%), sucrose per cent in juice, sucrose per cent in cane, purity (%), fibre (%), commercial cane sugar (%), commercial cane sugar yield (t/ha) and P and K content in juice (ppm) as affected by different treatments are presented in Table-1.Treatment V_2 (Co 86032) recorded significantly higher brix (%) (20.80 %), sucrose per cent in juice (19.07 %), sucrose per cent in cane (14.67 %) and commercial cane sugar (%) (13.42) as compared to rest of other treatments while purity (%) (92.80 %) and commercial cane sugar yield (11.03 t/ha) were significantly higher with treatment V_3 (Co N 5071) which was being at par with treatment V_2 (Co 86032) and treatment V_4 (Co N 7072) in case of commercial cane sugar yield. P content in juice (555.0 ppm) was significantly higher with treatment V_4 (Co N 7072). Fibre (%) and K content in juice was failed to show significant effect due to different varieties of sugarcane. These results may be due to differences in growth and their reaction to recorded among studies cane varieties. These results are in harmony with those reported by Ahmed (2017) [1].

Effect of phosphorus levels

Number of millable cane and millable cane yield

Applications of different levels of phosphorous were significantly affected on number of millable cane and millable cane yield. Treatment P_3 (150 kg/ha P_2O_5) recorded significantly higher number of millable cane (86183) and millable cane yield (91.31 t/ha) which was remained at par with treatment P_2 (100 kg/ha P_2O_5) in case of number of millable cane per hector. The possible reason for higher yield attributes and yield of sugarcane might be due to the fact that phosphorus involved in increasing the protoplasmic constituents and accelerating the process of cell division and elongation which in turn give luxurious vegetative growth. Optimum phosphorous application resulted in healthy root developments which ultimately develop secondary rootlets resulting in maximum root surface area for soil contact so plant can take better absorption of nutrients and efficient photosynthesis for higher productivity. This is in agreement with the findings reported earlier by Shukla and Singh (2011) [9], Chohan *et. al*. (2012) [2], Kumar *et al*. (2012) [4], Kumar *et. al*. (2014) [5] and Yadav *et al*. (2016) [11].

Quality parameters

Different quality parameters of sugarcane *viz*., brix (%), sucrose per cent in juice, sucrose per cent in cane, purity (%), fibre (%) and commercial cane sugar (%) were did not affect significantly due to different levels of phosphorous application. Treatment P_3 (150 kg/ha P_2O_5) recorded significantly higher C.C.S. yield (12.05 t/ha), P content in juice (534.6 ppm) and K content in juice (2971.8 ppm) which was remained at par with treatment P_2 (100 kg/ha P_2O_5) for K content in juice. This might be due to increasing in availability of plant nutrients as a result of this; the fertility status of the soil might have increased which increased the absorption of plant nutrients. Enhanced tillering recorded under this treatment must also have contributed to the yield and the lowest yield of commercial can sugar yield was observed under lowest fertility levels. These results are in agreement with the finding of Kumar *et. al.* (2012) [4] and Santos *et.al*. (2014) [7].

Interaction effect

Number of millable cane and millable cane yield (t/ha) were significantly affected by interaction effect of different variety of sugarcane and different levels of phosphorus application. Quality parameters of sugarcane *viz.*, brix (%), sucrose per cent in juice, sucrose per cent in cane, purity (%), fibre (%), commercial cane sugar (%), commercial cane sugar yield (t/ha) and P and K content in juice (ppm) did not affect significantly due to interaction effect between different varieties of sugarcane and different levels of phosphorous application (Table-1).

From Table-2 data revealed that treatment combination of V_4P_3 (Co N 7072 and 150 kg/ha P_2O_5) recorded significantly higher number of millable cane per hectare (96441) which was remained at par with treatment V_3P_2 (Co N 5071 and 100 kg/ha P_2O_5) and V_3P_3 (Co N 5071 and 150 kg/ha P_2O_5). Significantly higher millable cane yield (105.08 t/ha) was observed with treatment V_4P_3 (Co N 7072 and 150 kg/ha P_2O_5) which was being at par with V_3P_3 (Co N 5071 and 150 kg/ha P_2O_5) and V_4P_2 (Co N 5071 and 100 kg/ha P_2O_5) (Table-3).

Table 1: Yield and quality parameters of sugarcane as affected by different treatments (Pooled over two years)

Treatments	Numbers of millable cane/ha	Millable cane yield (t/ha)	Brix (%)	Sucrose per cent in juice	Sucrose per cent in cane	Purity (%)	Fibre (%)	C.C.S. (%)	C.C.S. yield (t/ha)	P content in juice (ppm)	K content in juice (ppm)
Variety (V)											
V_1	76184	74.04	19.52	18.08	13.91	86.56	13.03	12.77	9.49	429.6	2824.6
V_2	78116	79.08	20.80	19.07	14.67	80.37	13.06	13.42	10.64	471.3	2870.0
V_3	83768	84.48	19.99	18.45	14.17	92.80	13.17	13.02	11.03	520.4	2910.4
V_4	85113	88.93	19.73	17.67	13.57	88.10	13.21	12.30	10.99	555.0	2929.6
S.Em. ±	1893	2.02	0.18	0.14	0.09	0.76	0.08	0.10	0.36	3.8	39.18
C. D. at 5%	5468	5.82	0.51	0.40	0.27	2.16	NS	0.29	1.05	10.8	NS
P_2O_5 levels (P)											
P_0	76129	72.63	19.66	18.04	13.90	85.73	12.98	12.70	9.14	449.6	2813.2
P_1	79227	78.30	19.90	18.23	14.02	86.55	13.07	12.82	9.98	480.4	2851.8
P_2	81642	84.28	20.12	18.41	14.14	87.37	13.16	12.93	10.98	511.7	2892.8
P_3	86183	91.31	20.36	18.59	14.26	88.19	13.25	13.05	12.05	534.6	2971.8
S.Em. ±	1893	2.02	0.18	0.14	0.09	0.76	0.08	0.10	0.36	3.8	39.18
C. D. at 5%	5468	5.82	NS	NS	NS	NS	NS	NS	1.05	10.8	113.14
Interaction (V X P)											
S.Em. ±	3787	4.03	0.35	0.28	0.19	0.35	0.15	0.11	0.73	4.0	78.36
C. D. at 5%	10936	11.65	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV %	8.12	8.56	3.04	2.61	2.28	4.31	2.00	3.86	11.95	3.79	4.71

Table 2: Interaction effect of different varieties and phosphorus levels on number of millable cane of sugarcane (Pooled over two years)

	Number of millable cane per hectare				
Treatment	P_0	P_1	P_2	P_3	Mean (V)
V_1	71685	78528	79662	74860	76184
V_2	77939	78879	78263	77382	78116
V_3	74279	77439	87307	96048	83768
V_4	80614	82061	81335	96441	85113
Mean (P)	76129	79227	81642	86183	
S.Em.±	3787				
C.D. at 5 %	10936				
C.V. %	8.12				

Table 3: Interaction effect of different varieties and phosphorus levels on millable cane yield of sugarcane (Pooled over two years)

	Millable cane yield (t/ha)				
Treatment	**P_0**	**P_1**	**P_2**	**P_3**	**Mean (V)**
V_1	68.75	71.08	75.92	80.40	74.04
V_2	75.55	82.61	76.17	81.99	79.08
V_3	67.53	77.13	91.67	101.58	84.48
V_4	74.90	79.92	95.84	105.08	88.93
Mean (P)	71.68	77.68	84.90	92.26	
S.Em.±	4.03				
C.D. at 5 %	11.65				
C.V. %	8.56				

Conclusion

On the basis of experimental results, it can be concluded that in P deficient soil for getting higher yield of sugarcane, variety Co N 7072 or Co N 5071 should be nourished with 150 kg/ha P_2O_5 under South Gujarat conditions.

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