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Influence of Sulphate of Potash (Sop) and Farmyard Manure (Fym) on Sugarcane (*Saccharum officinarum* L.) Grown Under Salt Stress

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Abstract

The effects of increasing soil fertility with sulphate of potash (SOP) and/or farm-yard manure (FYM) on salt tolerance of two sugarcane varieties i.e. SPSG-26, and CP77-400, were assessed. Potash fertilizer (K_2SO_4) was applied @ 0, 100 and 200 kg K_2SO_4 ha^{-1} to sugarcane field with and without organic manure (FYM). Both FYM and potash fertilizer significantly reversed the effects of salinity, increased nitrate reductase activity (NRA), transpiration rate, flag leaf area, cane yield and sugar recovery and decreased stomatal diffusive resistance. Sugarcane variety SPSG-26 exhibited better response to FYM and potash fertilizer than CP77-400 under saline conditions for cane yield, stomatal diffusive resistance, whereas both varieties showed non significant differences for flag leaf area, sugar recovery and transpiration rate.

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Key words: Sulphate of potash, Farmyard manure, Sugarcane, Salt stress

Introduction

Sugarcane (*Saccharum officinarum* L.) is an important cash crop of Pakistan. It is graded as a moderately salt sensitive crop (Maas, 1987). In Pakistan more than 6.173 million hectares land is affected by salt (Anonymous, 2000), which interfere with sugar production in two ways, either by affecting the growth rate and yield of millable cane or by reducing sucrose contents of stalk (Nasir *et al.*, 2000). Salinity reduces water content, leaf area, photosynthetic parameters and nitrogen contents in sugarcane (Shamshad *et al.*, 2001; Meinzer *et al.*, 1994). There are many reports which indicate that effect of salinity can be minimized by increasing K^+/Na^+ ratio (Sinha, 1978).

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Potassium is required for cell wall development, carbon assimilation, photosynthesis, synthesis and translocation of organic and inorganic nutrients from soil to plant (Thangavelue and Rao, 1997 and Subramanian, 1994).

Similarly FYM provides a good source of N, P and K^+ (Vijakumar *et al.*, 2001). Nitrogen is essentially required in the synthesis of aminoacids, proteins and enzymes for metabolic pathways. Its application increases the cane and sugar yield either applied alone (Kathiresan and Manoharan, 1999) or incombination with potash fertilizer (Vinay *et al.* 1991). However, non significant effects of potash application on cane yield and sucrose contents have been reported (Dhillon *et al.*, 1993; Ayub *et al.*, 1999).

Sugarcane is a high input demanding crop and depletes soil nutrients heavily. Its once cultivation may remove nitrogen, phosphorous, and potassium upto to 70, 20 and 200 kg ha^{-1} respectively thus heavily, depleting the soil nutrients (Verma and Dang, 1995). If the depleted nutrients are not replaced, soil fertility and soil organic matter level go down creating a stress soil environment that essentially requires an optimal and balanced use of fertilizers (Ahmad, 2002).

Therefore, an attempt was made to alleviate the effect of salinity necessary for the cultivation of sugarcane in salt affected soils and the response of salt tolerant and sensitive varieties had been assessed by the application of K^+ nutrient and organic manure to saline conditions.

Materials and Methods

To determine the improvement in salt tolerance in sugarcane by the application of potash [sulphate of potash, K_2SO_4] and organic manure (farmyard manure) under saline conditions, a field experiment was conducted at Samundri Faisalabad, Pakistan.

The experiment consisted of six treatments including control each with three replicates and was laid out in a split-split plot design. Two sugarcane varieties, salt tolerant (SPSG-26) and salt sensitive (CP77-400) were used. Following were the fertilizer or organic manure treatments:

T_0	=	M_0K_0	T_1	=	M_0K_1
T_2	=	M_0K_2	T_3	=	M_1K_0
T_4	=	M_1K_1	T_5	=	M_1K_2
M_0	=	(FYM) 0 t ha^{-1}	K_0	=	0 kg K_2O ha^{-1}
M_1	=	(FYM) 4 t ha^{-1-}	K_1	=	100 kg K_2O ha^{-1}
			K_2	=	200 kg K_2O ha^{-1}

The texture of the soil used was clay loam with average ECe 11.005 dSm^{-1}, pH 8.98, SAR 57.5, Na^+ 85 meq L^{-1}, K^+ 1.28 meq L^{-1}. Seeds were sown in furrows with furrow-to-furrow distance of 75cm. FYM @ 4 t ha^{-1} was mixed in selected plots before sowing, whereas potash fertilizer (K_2SO_4) @ 0, 100, 200, kg K_2O ha^{-1} was applied in two split doses, before and after sowing.

Data for flag leaf area (Carleton and Foote's, 1965), nitrate reductase activity (Sym, 1984), transpiration rate, stomatal diffusive resistance (Porometer), cane yield and sugar recovery (Refrectometer) were subjected to statistical analysis for the comparison of treatment means. (Snedecor and Cochran, 1989).

Results

Under saline conditions FYM and potash application significantly increased flag leaf area of both varieties. Increase by potash was more significant than with FYM treatment. There was non significant difference in increase in leaf area with 100kg and 200 kg potash application in variety SPSG-26. However, variety CP 77-400 exhibited significant differences among these treatments (Fig. 1).

Varieties depicted variable response to potash. Potash fertilizer application at 100 kg ha^{-1} significantly increased the transpiration rate in CP 77-400 but decreased in SPSG-26. The pattern was reverse at 200 kg ha^{-1} (Fig. 2). FYM application showed non significant increase in transpiration rate. Reduction in diffusive resistance in both varieties was recorded due to manure and potash application. Highest value of diffusive resistance was recorded at K_0 level (0kg K_2O ha^{-1}) while the lowest was at K_2 level (200kg K_2O ha^{-1}) (Fig. 3) in both varieties. As compared to potash fertilizer the decrease was less with FYM in both varieties.

Significant increase in nitrate reductase activity (NRA) in CP 77-400 was recorded with potash and FYM application but in SPSG-26 the case was opposite (Fig. 4). The interaction of FYM and potash application enhanced flag leaf area, NRA, transpiration rate but decreased stomatal diffusive resistance. The potash fertilizer application showed significant increased regarding cane yield and sugar contents in both varieties. Highest cane yield was recorded at K_2 level (200 kg K_2O ha^{-1}) and lowest at K_0 level (0 kg K_2O ha^{-1}) in both varieties. However, the increase in cane yield was less significant with FYM as compared to potash fertilizer (Fig. 5). Sugar recovery in cane increased significantly from 10.7% to 14.5% with potash and from 10.7 to 12% with FYM in SPSG-26 while 12% to 14.6% with potash and 12% to 12.2% with FYM in CP 77-400. Both potash levels K_1 (100 kg K_2O ha^{-1}) and K_2 (200 kg K_2O ha^{-1}) showed same increase (35.51%) in SPSG-26 while with FYM application it was only 12.15% over control. Interaction of FYM and potash application showed non significant differences for increase in cane yield and sugar recovery. The highest cane (50 t ha^{-1}) yield was recorded in M_1K_2 (FYM with 200 kg K_2O ha^{-1}) in SPSG-26 and the lowest (31.20 t ha^{-1}) in M_0K_0 (control). Highest increase in cane yield was 60% at M_1K_2 (FYM with 200 kg K_2O ha^{-1}) than control in SPSG-26. SPSG-26 performed better than CP 77-400 for cane yield, stomatal diffusive resistance, whereas CP 77-400 had an edge over its counterpart in case of nitrate reductase activity. For flag leaf area, transpiration rate and sugar recovery both varieties showed non significant differences.

Discussion

Saline soils drastically affect the physiology of plants. Torres *et al.*, (1974) supported the assumption that excessive Cl^- in rooting medium inhibits the NO^-_3 uptake and it was more pronounced under saline conditions which caused a decrease in NRA. Similar results were reported by Iqbal *et al.*, 2002 and Salim *et al.*, 2002. However, organic manure amendments and application of potash fertilizer compensated this loss to some extent in the present investigation, as FYM and potash application increased uptake of N in wheat (Vinay *et al.*, 1991).

Diffusive resistance is opposite to stomatal conductance and it exhibits suppression in CO_2 assimilation (Taiz and Zeiger, 1998). Transpiration rate decreased and diffusive resistance increased with salinity levels because salt accumulation in the rooting zone leads to decreasing water potential. With increasing water stress, physiological disorders may occur such as decrease in transpiration and assimilation rates as recorded for pepper and cotton (Shalhevet and Hsiao, 1986 ; Sharma, 1995). With the application of organic manure and potash fertilizer rate of transpiration increased. Potassium is decisively involved in the water economy of plants. It is well established that plants adequately supplied with potassium can utilize the soil moisture more efficiently than potassium deficient plants. Potassium uptake in to the cell may contribute to osmotic potential of cytoplasm which is prerequisite of osmotic water uptake (Mengel and Arneke, 1982).

Similarly potassium plays an important role in stomatal opening. Plants treated with organic manure (FYM) and potash fertilizer (SOP) produced higher flag leaf area, cane yield and sugar contents. This may be due to the presence of not only organic matter but also some essential elements necessary for plant growth, as all organic manures are good source of N, P and K^+ (Gulshan *et al.*, 1999). Similarly, potassium plays vital role in plant growth and development (De Boer, 1999). It is needed for various vital processes necessary for development. As a consequence of active uptake of potassium and its accumulation in the cell, osmotic potential decreases, water moves in and increases the turgor pressure in the cell which is responsible for growth. Organic manure such as FYM have been reported to increase the leaf area and beneficial for growth and photosynthetic efficiency (Taiz and Zeiger, 1998); higher the flag leaf area higher will be photosynthesis and greater will be the growth rate. The induction in FLA may be due to enhancement in cell division, which can happen only in those plants, which have the capability to maintain their turgor potential, and from literature it is evident that K^+ is helpful in maintaining turgor potential in plants (Venekamp *et al.*, 1989).

Positive effect of potash fertilizer and FYM application occurred on cane yield and sugar contents confirming earlier reports (Vijay-Kumar *et al.*, 2001). Potash application increased the growth and yield of sugarcane (Bangar, 1995). On the contrary, Singh *et al.* (1999) reported that potassium application had non-significant effect on cane yield but increased commercial cane sugar content. Verma *et al.* (1998) reported that potassium application gave higher cane yield but had no effect on sugar content. Our results suggest the positive role of FYM and potash fertilizer for improving cane yield and sugar contents under saline conditions.

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