

Role of potassium in sugarcane

for improving yield and farmers' income

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Sugarcane is an important industrial crop responsible for producing jaggery, bioethanol, bagasse and sugar. While staying a bit longer in the field, it uptakes a significant amount of nutrients, viz. nitrogen, phosphorus and potassium. Enough studies have been carried out for delineating the sustainable doses for nitrogen and phosphorus, except for potassium assuming it's enough availability in the soils due to dominance of illite minerals. Since last decade, reports have indicated potash deficiency in Punjab region and there is a need to apply potash fertilizers for fulfilling the cane requirements. But, till date in Punjab, no K dose is recommended even for deficient sites which have resulted in lower productivity. However, potassium has a role to play in activation of different enzymes, in regulating turgidity by controlling stomatal cells openings, in reducing top-borer attacks, in enhancing cane root growth and finally in improving the nitrogen use efficiency in the region. Studies carried out in deficient soils revealed 80 kg K/ha as the most sustainable and climate smart dose for enhancing different growth, yield and quality parameters which are further reported to reduce the overall costs of cultivation and improve the livelihoods of the cane farmers.

Keywords: Livelihoods, Potash, Stomata openings, Sugarcane, Top borer

SUGARCANE (*Saccharum* spp. complex) being cultivated at an area of 23.8 million hectare (mha) is a crop of industrial importance. It is grown in 110 countries of tropical and sub-tropical regions of the world and is known for jaggery and khandsari, along with the commercially important by-products like bagasse, molasses, filter-cake, wax etc. Sugarcane is cultivated in most of the states of India, viz. Uttar Pradesh (38.57%), Maharashtra (17.76%) and Karnataka (12.20%) with total area coverage of 5.03 mha. For having yield potential of 100 t/ha, canes remove 207 kg N, 30 kg P_2O_5 and 233 kg K_2O from the soil, and for regaining these, fertilizers have to be added back in the soil. Potash plays an important role in plant physiological and metabolic activities.

Potassium aids in photosynthesis, the mechanism by which the carbohydrates and energy required

for plant growth is generated and transformed. It is one of the third macronutrients that plays important roles, viz. transport glucose from leaves to the whole plant, reduces insect-pest incidences, improves roots and thus rhizosphere which further improves the water and N use efficiency, regulates stomata openings particularly during stress conditions, acting as a cofactor for more than 60 enzymes, etc. Being reported to regulate the stomatal opening and closing, potassium helps in regulating the turgor pressure under the prevailing water stressed conditions. Lastly potassium also helps in the transportation of the so prepared food/glucose from leaves to cane stalk thereby making the leaves comparatively bitter as compared to the control plots where no potash is being applied, which further results in lesser attack of the top borers. This results in lesser pesticide sprays

which further decrease overall costs and enhances the benefits of the cane farmers under both irrigated and water stressed conditions.

Sugarcane is a carbohydrate-rich crop that requires a lot of potassium. But in Punjab for sugarcane, till date, there are no K fertilizer recommendations even for the deficient soils. Hence, for standardizing K dose in sugarcane using CoJ 88, experiments during plant 2019–20 and 2020–21 ratoon crop, under irrigated (I1) and water-stressed (I2) plots in the main plots and 0, 40, 80, and 120 kg K_2O /ha as K1, K2, K3, and K4, respectively in the subplots were carried out at Regional Research Station, Kapurthala, Punjab. Under I2 treatment, irrigation was suspended after a 3-week interval at critical growth stages of sugarcane, viz. germination, tillering and grand growth stage. During 2019–20 and 2020–21, average maximum

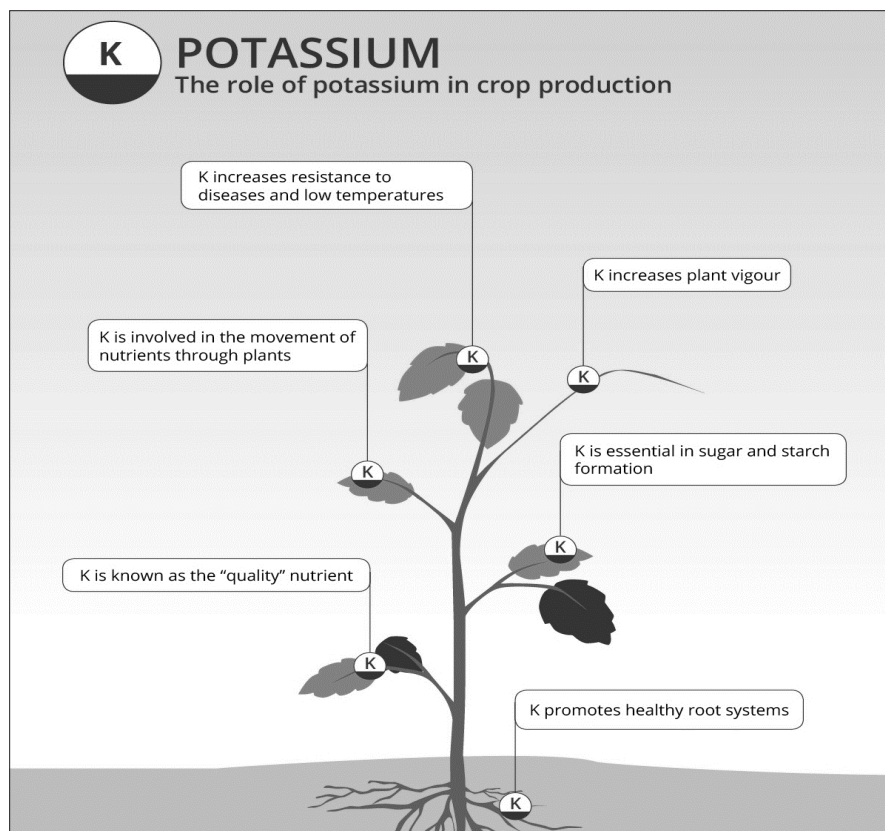
Table 1. Sugarcane germination, CCS (%) at 10th and 12th months, top borer incidence and yields as affected by different levels of irrigations and potash during plant (2019–20) and ratoon crop (2020–21)

Treatment	Germination (%)		CCS (%) 10th month		CCS (%) 12th month		Top borer		Yield (t/ha)	
	2019–20	2020–21	2019–20	2020–21	2019–20	2020–21	2019–20	2020–21	2019–20	2020–21
I ₁	49.76 ^a	47.75 ^a	13.10 ^a	12.57 ^a	13.42 ^a	13.13 ^a	9.3 ^a	10.2 ^b	77.54 ^a	57.69 ^a
I ₂	46.81 ^b	44.79 ^a	12.98 ^a	12.50 ^a	13.40 ^a	13.05 ^a	10.4 ^a	11.3 ^a	77.20 ^a	56.95 ^a
K ₁	40.95 ^c	41.91 ^c	12.41 ^c	12.25 ^c	13.07 ^b	12.83 ^b	10.5 ^a	11.8 ^a	76.30 ^b	55.93 ^b
K ₂	46.55 ^b	44.52 ^b	12.85 ^b	12.45 ^{bc}	13.25 ^b	13.11 ^{ab}	10.2 ^a	10.8 ^b	76.86 ^b	56.49 ^b
K ₃	51.17 ^a	49.17 ^a	13.45 ^a	12.74 ^a	13.67 ^a	13.12 ^{ab}	9.0 ^a	9.5 ^c	77.96 ^a	58.21 ^a
K ₄	54.18 ^a	52.15 ^a	13.47 ^a	12.69 ^{ab}	13.69 ^a	13.28 ^a	9.7 ^a	10.8 ^b	78.38 ^a	58.64 ^a

Note: Superscript letters are based on the data analyzed using the SAS program and subjected to analysis of Variance (ANOVA) and the treatment means were compared by Duncan's multiple range test (DMRT).

and minimum temperature varied from 7.8–42.4°C and 10.2–25.1°C while during 2020–21, it varied between 19.2–37.5°C and 7.0–27.6°C, respectively. Results of irrigated plots though had higher values of the parameter, viz. CCS (%) at 10th and 12th months, top borer incidence and yields during both years were statistically at par to the water-stressed plots, except for germination during 2019–20 (Table 1) where irrigated plots outperformed the stressed plots. I₁ plots had higher germination (6.3% and 6.6% during 2019–20 and 2020–21), CCS (0.92% and 0.56% during 2019–20 and 2020–21), and lesser top borer incidence (10.58 and 9.73% during 2019–20 and 2020–21).

Further, coming over to the benefits, higher profits were reported in the I₂, viz. water-stressed plots due to lower yields in the control plots as compared to the I₁ plots. Further, 80 kg K₂O/ha reported higher profits as compared to any other treatment under both irrigation main plot treatments and the same trends were reported when treatments averaged over the irrigation calculated (Table 2). No doubts, increments were there (but those were not sustainable) while shifting to 120 kg K₂O/ha as those were at par with 80 kg K₂O/ha, which rather increased the benefits. Therefore, based on experiments carried out at PAU-Regional Research Station, Kapurthala, Punjab from 2019–20 to 2020–21, it was concluded that the application of 80 kg K₂O/ha gave significantly higher germination, yield, and CCS (%) as compared to the 0 and 40 kg K₂O/ha. Increments were there in K₄ plots with 120 kg K₂O/ha but were



Potassium role in plant for enhancing growth, yield and quality parameters
(Source: <https://www.iclfertilizers.com/potassium>)

Table 2. Effect of Potash and irrigation levels on benefit:cost ratio in sugarcane crop during plant (2019–20) and ratoon crop (2020–21)

Treatment	Benefit:cost ratio			Overall trend	
	2019–20	2020–21	K dose (kg K ₂ O/ha) averaged over irrigation treatments	2019–20	2020–21
I ₁ K ₁	0	0.0			
I ₁ K ₂	1.5	0.9	0	--	--
I ₁ K ₃	1.9	2.3	40	1.3	1.3
I ₁ K ₄	1.5	1.7	80	1.9	2.6
I ₂ K ₁	0.0	0.0	120	1.6	2.3
I ₂ K ₂	1.1	1.7			
I ₂ K ₃	1.9	3.0			
I ₂ K ₄	1.7	2.5			

Note: Rate of muriate of potash: ₹950/50 kg bag; *Price of Sugarcane: ₹2950/t.

statistically at par with K3 plots with 80 kg K₂O/ha.

Potassium through its interactive role helps in the improved nitrogen use efficiency and thereby helps in reducing cultivation costs and also helps in mitigating the adverse effects of the global warming. Further, potassium helps in the proper root development by which plants could explore more soil area for their nutritional needs and also suffer less from the lodging problem, and are further reported with good yield and quality indicators.

SUMMARY

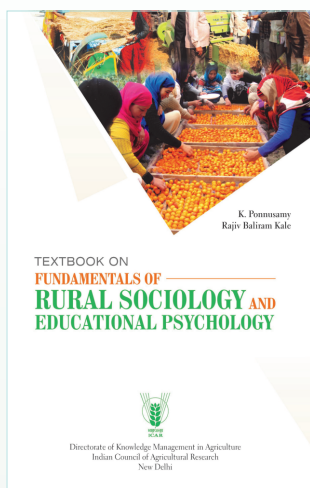
Sugarcane is a different crop as it stays in the field from 11–12 months in the field depending on its cultivars. For meeting the cane requirements for plant as well as for the ratoon crop, different quantum

of the nutrient is required. Among different nutrients, potassium is the most neglected nutrients in both plants as well as in the ratoon cane crops, as far as sugarcane fertilization is concerned. It is estimated around 0.27–2.7 kg of potash is required for producing one tonne of sugarcane crop. Potassium plays many important roles in sugarcane, viz. in maintaining the turgidity during water stressed conditions by regulating the openings of the cane leaves stomata, thus helping in managing the water stressed conditions without adversely affecting the yields and quality parameters. Further, K also enhances the root growth deep in the soils, thereby avoiding lodging losses. At deficient soils, K helps in photosynthesis end products to move from leaves to whole plant,

thereby reducing sweetness of cane leaves which further reduces the insect-pests attacks and hence the amounts of used pesticide which in-turn reduces the overall cultivation costs. Thus, there was a need to recommend a suitable dose of K for the K deficient soils in Punjab and therefore, two-year experiments were carried out at deficient soils which revealed 80 kg K₂O/ha being the most sustainable and climate smart dose for reducing insect-pests attacks, improving cane growth, yields, quality parameters, and improving livelihoods of the cane farmers in the region.

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TECHNICAL SPECIFICATIONS

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