

Effect of Potassium Solubilizing Bacteria (KSB) on the Performance of Sweet corn (*Zea mays* L. *saccharata*) in Potassium Sufficient Soil

ABSTRACT

An experiment was conducted on potassium sufficient sandy loam soil (*Alfisols*) to evaluate the impact of potassium solubilizing bacteria (KSB) on the performance of *rabi* sweet corn. The study consisted of 10 treatments with different doses of potassium with and without KSB treatment [Seed treatment (ST) + Soil drenching (SD)]. Result of this experiment indicated that sweet corn yield was gradually reduced with reduction of recommended dose of potassium (RDK) irrespective of KSB treatment. Amongst all treatments, application of 100% RDK in 2 equals split at sowing and knee height (KH) stage + KSB (ST + SD) resulted in significantly highest growth, yield (19.7 t ha^{-1}) and yield attributes which were on par with the result of [100% RDK + KSB (ST) + KSB (SD)], (50% RDK at basal + 50% RDK at KH stage), [100% RDK + KSB (ST) +KSB (SD)] and [75% RDK at basal + KSB (ST) +KSB (SD)] treatments. Whereas, implication of 25% or 50% reduction of RDK was significantly inferior to 100% RDK. The study revealed that KSB could substitute 25% of RDK supplied to nutrient exhaustive crop like *rabi* sweet corn without compromising the economic yield in potassium rich *alfisols* of semi-arid tropics.

Key words: *Integrated nutrient management, Potassic fertilizer, K- split application, Telangana*

1. INTRODUCTION

Corn or Maize (*Zea mays* L.) is one of the most important cereal crops in the world with multifarious uses after rice and wheat. In India, total cultivated area under maize was 9.89 M ha with an annual production of 31.6 Mt and average productivity of 3,199 kg ha⁻¹ [1]. Sweet corn (*Zea mays* L. *saccharata*) is a type of corn grown for human consumption as raw or processed food throughout the world.

As far as plant nutrition is concerned, potassium (K) is a very important macronutrient which controls plant water status, it regulates ionic balances, activity of stomata cells to prevent unnecessary water loss by transpiration, K plays a significant role in photo-synthesis and in the production and translocation of carbohydrate to areas of meristematic growth, fruit development, and storage and also aids in activation of more than 60 enzymes which catalyse various metabolic process [2].

In India, there is very limited source of K-ore for manufacturing potassic fertilizer, hence, the entire required amount of K-fertilizer is imported from abroad in the form of muriate of potash (KCl) and sulphate of potash (K₂SO₄). The total import of muriate of potash (MOP) during the year 2020 was more than 5.08 Mt [3]. Govt. of India is giving subsidy of Rs. 759 bag⁻¹ (50 kg) to keep the domestic MOP price (Rs. 1675 bag⁻¹) within the reach of farmer, when international price of MOP is Rs. 2434.61 bag⁻¹ [4]. It imposes huge monetary burden to the Indian government. Keeping in view, in the year 2023, The Indian government planned to introduce a new scheme – PM PRANAM (PM Promotion of Alternate Nutrients for Agriculture Management Yojana) to rely on all natural ways and resources in lieu of chemical fertilizers to grow the crops.

In India, 79% of soils are medium to high in inherent potassium (K) status [5]. Depending on the soil around 98 % of total soil K was found in unavailable form [6]. As the conversion process of unavailable to available K is a very slow process and not sufficient to replenish the dearth of available potassium in crop growing season, soil microorganisms can play a significant role in solubilization process through acidolysis, production of organic acids, chelation, complexolysis, and ion-exchange reactions [7].

Keeping in view high import of potassic fertilizers to India and its monetary burden on economy, high potassium demand by sweet corn, sufficiency of soil potassium but in unavailable form and considerable potential of KSB in converting un-available soil potassium and making it available to the crop, there was a urgent need to assess and quantify the efficacy of KSB in potassium management *vis-à-vis* minimizing chemical fertilizers requirement in *rabi* sweet corn.

2. MATERIALS AND METHODS

A field experiment was conducted during *rabi* season (November- February) (2022-23) at College farm of Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, India (17° 19' 18" N latitude, 78° 24' 31" E longitude, with an elevation of 542.6 m above mean sea level) which is under semi-arid tropic region (SAT). The soil (p^H=7.45) was sandy loam in texture, deficient in soil organic carbon and available N, and rich in available-P and available-K. During the crop growth period, the weekly mean maximum atmospheric temperature ranged from 34.2°C to 28.4°C with an average of 30.4°C and mean minimum atmospheric temperature ranged from 18.2°C to 10.8°C with an average of 14.7°C (Figure 1).

The experiment, consisted of 10 potassium management practices, was laid out in randomized block design with 3 replications. The 10 treatments were- T₁: 0% RDK (Recommended dose of potassium), T₂: 100% RDK (Basal) (50 kg ha⁻¹), T₃: 50% RDK (Basal) (25 kg ha⁻¹), T₄: 75% RDK (Basal) (37.5 kg ha⁻¹), T₅: 50% RDK (Basal) + 50% RDK [at Knee Height (KH) stage], T₆: T₁ + KSB [Seed Treatment (ST)] + KSB [Soil Drenching (SD)] at KH stage, T₇: T₂ + KSB (ST) + KSB (SD) at KH stage, T₈: T₃ + KSB (ST) + KSB (SD) at KH stage, T₉: T₄ + KSB (ST) + KSB (SD) at KH stage, T₁₀: T₅ + KSB (ST) + KSB (SD) at KH stage. Seeds of variety Madhuri were treated with KSB (procured from Dept. of Microbiology, PJTSAU) @ 10 ml kg⁻¹ seed and for soil drenching 2.5 ml KSB was mixed with 1 L of water. Quantity of water used for KSB soil drenching was 20 ml water plant⁻¹ and the recommended dose of fertilizer (RDF) was 200: 60: 50 (N: P₂O₅: K₂O) kg ha⁻¹. Urea, single super phosphate (SSP) and muriate of potash (MOP) were used as sources of N, P and K respectively for soil application. The data recorded on various parameters were analysed statistically duly following the technique of analysis of variance for randomized block design [8].

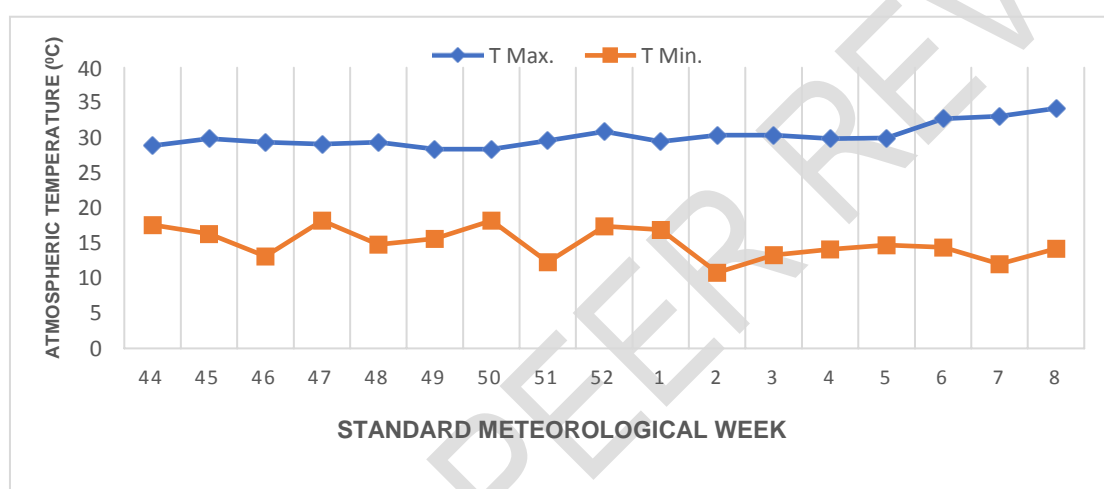


Fig 1. Weekly maximum and minimum temperatures (°C) during the crop growth period

3. RESULTS AND DISCUSSION

3.1 Growth parameters:

Perusal of the data (Table 1) indicated that numerically highest plant height was recorded with T₁₀ [50% RDK (Basal) + 50% RDK at KH stage + KSB (ST) + KSB (SD) at KH stage] treatment at different stages. However, at KH stage there was no significant difference in plant height owing to different treatment imposition, except T₁ (0% RDK) and T₆ [0% RDK + KSB (ST) + KSB (SD)] treatment. Numerical increment of plant height with increase dose of potassium might be due to proper photosynthesis and cell growth which is in consonance with [9].

On the other hand, after KH stage there was some significant changes in leaf area index (LAI) and drymatter due to treatment imposition. At KH stage significantly lower LAI and

drymatter were resulted from T₁ and T₆ treatment but remaining treatment were statistically on par. At Tasselling and Harvesting stage numerically highest LAI and drymatter were recorded from T₁₀ treatment which was on par with T₅, T₂, T₇ and T₉ treatments. Whereas, further reduction of potassium dose irrespective of KSB treatment resulted in impaired growth in both stages, however, T₄ and T₈ treatment showed insignificant result and those results were superior over T₁, T₃ and T₆ treatments in terms of LAI and drymatter production. These findings are in close agreement with [10]

Significant improvement of growth parameter due to increment in K-fertilizer or partial substitute of RDK with KSB dose might be attributed to maintenance of cell osmotic pressure and improvement in carbon and nitrogen assimilation and optimization of photosynthesis as reported by [11] [12] [13] [14].

3.2 Yield attributes:

Experimental result (Table 2) revealed that there was some significant positive impact of K and KSB on cob weight plant⁻¹, Cob girth and number of kernel row⁻¹ whereas, no. of cob plant⁻¹, cob length, no. of kernel row cob⁻¹ were not significantly influenced by different treatment. Cob weight plant⁻¹, cob girth, and no. of kernel row⁻¹ were increased by 40.6%, 66.6% and 43.3% respectively due to the T₁₀ over T₁ treatment and T₁₀ treatment was on par with T₅, T₇, T₂ and T₉ treatments. Furthermore, T₉ i.e., 75% RDK + KSB (ST+SD) resulted into statistically equal impact on change in cob girth, no. of kernels row-1 and cob weight plant-1 when compared with the highest treatment (T10). This indicated considerable potential of KSB in soil and their potential to solubilize soil mineral K into water soluble and exchangeable fractions. Gradual inferiority of yield attributes owing to reduced K application is also aligned with the findings of [10] in maize in K rich soil. Increment in yield attributes might be resulted from optimum supply of K which might have helped in proper grain filling and translocation of photosynthates from source to sink [15].

3.3 Yield:

Significantly highest cob yield, green fodder yield were obtained from T₁₀ treatment which was statistically similar with T₅, T₇, T₂ and T₉ treatments. Eventually harvest index (HI) was also insignificantly influenced by K management practices. It is noteworthy that in between basal and 2 equal split applications of 100% RDK, latter gave the superior result irrespective of KSB treatment. It supports the findings of [16].

This result also implied that KSB could make 75% RDK (37.5 kg K₂O ha⁻¹) equivalent to 100% RDK (50 kg K₂O ha⁻¹) with its potential to solubilize the unavailable soil-K [17]. These findings are also in accordance with [18] [10] where application of K showed significant impact in corn, despite having high inherent soil-K.

4. Conclusion

It could be concluded that in spite of having high inherent soil-K, it is imperative to supply 100% RDK (50 kg K₂O ha⁻¹) to get higher yield. However, partial substitution of synthetic K upto the extent of 25% is possible by treating corn seed with KSB followed by soil drenching at Knee height stage without compromising the potential yield in *alfisols* of semi arid tropic.

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Table 1: Influence of Potassium Solubilizing Bacteria (KSB) on growth parameters of *rabi* Sweetcorn.

Treatments	Plant height (cm)			LAI			Drymatter (kg ha ⁻¹)		
	Knee height stage	Tasseling stage	Harvesting stage	Knee height stage	Tasseling stage	Harvesting stage	Knee height stage	Tasseling stage	Harvesting stage
T ₁ : 0% RDK	56.4	149.1	168.2	0.31	3.21	3.19	384	6987	14298
T ₂ : 100% RDK (Basal) (50 kg ha ⁻¹)	63.1	180.2	216.4	0.52	4.92	4.81	476	9065	17186
T ₃ : 50% RDK (Basal) (25 kg ha ⁻¹)	60.2	174.5	197.3	0.48	3.31	3.28	454	7016	14416
T ₄ : 75% RDK (Basal) (37.5 kg ha ⁻¹)	62.1	178.0	202.2	0.51	4.10	4.01	470	8037	15310
T ₅ : 50% RDK (Basal) + 50% RDK (at KH stage)	60.5	182.2	217.7	0.49	5.00	4.78	455	9185	17210
T ₆ : T ₁ + KSB (ST) + KSB (SD) at KH stage	57.6	150.6	170.3	0.32	3.29	3.23	395	6994	14325
T ₇ : T ₂ + KSB (ST) + KSB (SD) at KH stage	63.8	180.6	218.1	0.53	4.95	4.88	480	9110	17195
T ₈ : T ₃ + KSB (ST) + KSB (SD) at KH stage	61.5	175.4	198.4	0.50	3.89	3.82	465	7990	14913
T ₉ : T ₄ + KSB (ST) + KSB (SD) at KH stage	62.5	179.8	213.6	0.52	4.52	4.48	472	8987	16378
T ₁₀ : T ₅ + KSB (ST) + KSB (SD) at KH stage	61.7	183.5	220.8	0.50	5.20	5.12	467	9200	17244
SEm ±	2.9	7.4	8.9	0.02	0.26	0.23	19	362	581
CD (p= .05)	8.6	22.1	26.5	0.07	0.77	0.69	58	1076	1726

Table 2: Influence of Potassium Solubilizing Bacteria (KSB) on yield attributes of *rabi* Sweetcorn.

Treatments	Yield attributes					
	Cobs plant ⁻¹	Cob weight plant ⁻¹ (g)	Cob length (cm)	Cob girth (cm)	Number of kernel rows cob ⁻¹	Number of kernels row ⁻¹
T ₁ : 0% RDK	1.8	212.3	15.2	3.3	13.1	22.4
T ₂ : 100% RDK (Basal) (50 kg ha ⁻¹)	1.7	295.6	16.3	5.3	13.7	30.5
T ₃ : 50% RDK (Basal) (25 kg ha ⁻¹)	1.7	215.2	15.4	3.4	13.2	23.0
T ₄ : 75% RDK (Basal) (37.5 kg ha ⁻¹)	1.7	251.2	15.8	4.3	13.5	26.8
T ₅ : 50% RDK (Basal) + 50% RDK (at KH stage)	1.8	295.4	16.6	5.4	13.6	22.8
T ₆ : T ₁ + KSB (ST) + KSB (SD) at KH stage	1.7	214.6	15.4	3.4	13.1	20.9
T ₇ : T ₂ + KSB (ST) + KSB (SD) at KH stage	1.7	297.6	16.5	5.4	13.8	31.7
T ₈ : T ₃ + KSB (ST) + KSB (SD) at KH stage	1.7	244.5	15.7	4.1	12.9	25.9
T ₉ : T ₄ + KSB (ST) + KSB (SD) at KH stage	1.8	289.5	16.1	4.8	13.3	29.1
T ₁₀ : T ₅ + KSB (ST) + KSB (SD) at KH stage	1.7	298.5	16.8	5.5	13.2	32.1
SEm ±	0.1	11.4	0.9	0.3	0.3	1.2
CD (p= .05)	0.2	33.9	2.6	0.8	0.8	3.5

Table 3: Influence of Potassium Solubilizing Bacteria (KSB) on yield of rabi Sweetcorn.

Treatments	Green cob yield (t ha ⁻¹)	Green fodder yield (t ha ⁻¹)	Harvest Index (HI)
T ₁ : 0% RDK	15.1	17.9	45.8
T ₂ : 100% RDK (Basal) (50 kg ha ⁻¹)	19.1	22.2	46.2
T ₃ : 50% RDK (Basal) (25 kg ha ⁻¹)	15.5	18.3	45.9
T ₄ : 75% RDK (Basal) (37.5 kg ha ⁻¹)	16.1	18.8	46.1
T ₅ : 50% RDK (Basal) + 50% RDK (at KH stage)	19.5	22.6	46.3
T ₆ : T ₁ + KSB (ST) + KSB (SD) at KH stage	15.2	17.9	45.9
T ₇ : T ₂ + KSB (ST) + KSB (SD) at KH stage	19.3	22.4	46.3
T ₈ : T ₃ + KSB (ST) + KSB (SD) at KH stage	15.8	18.5	46.1
T ₉ : T ₄ + KSB (ST) + KSB (SD) at KH stage	18.0	20.9	46.3
T ₁₀ : T ₅ + KSB (ST) + KSB (SD) at KH stage	19.7	22.8	46.4
SEm ±	0.8	0.9	0.4
CD (p= .05)	2.2	2.6	1.2