Effect of Potassium Solubilizing Bacteria (~~KSB~~PSB) onthe~~Performance~~ GrowthofSweetcorn (*Zeamays*L.*saccharata*)inPotassium Sufficient Soil

ABSTRACT

An experiment was conducted on potassium sufficient sandy loam soil (*Alfisols*) to evaluate theimpactofpotassiumsolubilizingbacteria(~~KSB~~PSB)ontheperformanceof*rabi*sweetcorn.Thestudy consisted of 10 treatments with different doses of potassium with and without ~~KSB~~PSB treatment[Seed treatment (ST) + Soil drenching (SD)]. Result of this experiment indicated that sweet cornyieldwasgraduallyreducedwithreductionofrecommendeddoseofpotassium(RDP~~K~~)irrespectiveof~~KSB~~PSBtreatment.Amongstalltreatments,applicationof100%~~RDK~~RDPin2equalssplitat sowing and knee height (KH) stage + ~~KSB~~PSB (ST + SD) resulted in significantly highest growth,yield(19.7tha^{-1})andyieldattributeswhichwereonparwiththeresultof[100%~~RDK~~RDP+~~KSB~~PSB(ST) + ~~KSB~~PSB(SD)],(50% ~~RDK~~RDPatbasal+ 50%~~RDK~~RDPatKHstage),[100%~~RDK~~RDP+~~KSB~~PSB(ST)+~~KSB~~PSB (SD)] and[75%~~RDK~~RDPatbasal+~~KSB~~PSB(ST)+~~KSB~~PSB(SD)]treatments.Whereas,implicationof25%or 50%reduction of ~~RDK~~RDP was significantly inferior to 100% ~~RDK~~RDP.The study revealed that

Keywords:*Integratednutrientmanagement,Potassicfertilizer, K-splitapplication,Telangana*

Abbreviations:

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1. INTRODUCTION

Corn or Maize (*Zea mays* L.) is one of the most important cereal crops in the worldwithmultifariususesafterriceandwheat.InIndia,totalcultivatedareaundermaizewas9.89Mhawithanannualproductionof31.6Mtandaverageproductivityof3,199kgha^{-1}[1].Sweetcorn (*Zea mays* L. *saccharata*) is a type of corn grown for human consumption as raw orprocessedfoodthroughoutthe world.

As far as plant nutrition is concerned, potassium (K^{+}) is a very important macronutrientwhich controls plant water status, it regulates ionic balances, activity of stomata cells toprevent unnecessary water loss by transpiration, K plays a significant role in photo-synthesisand in the production and translocation of carbohydrate to areas of meristematic growth, fruitdevelopment,andstorageandalsoaidsinactivationofmorethan60enzymeswhichcatalysevariousmetabolicprocess[2].

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In India, there is very limited source of K-ore for manufacturing potassicfertilizer,hence,theentirerequiredamountofK-fertilizerisimportedfromabroadintheformofmuriateof potash (KCl) and sulphate of potash (K_2SO_4). 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. 759bag^{-1} (50 kg) to keep the domestic MOP price (Rs. 1675 bag^{-1}) within the reach of farmer,wheninternationalpriceofMOPisRs.2434.61bag^{-1}[4].Itimposeshugemonetaryburdentothe Indian government. Keeping in view, in the year 2023, The Indian government planned tointroduceanewscheme–PMPRANAM(PMPromotionofAlternateNutrientsforAgricultureManagementYojana)torelyonall naturalwaysandresourcesinlieuofchemicalfertilizerstogrow thecrops.

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InIndia,79%ofsoils are medium tohigh in inherent potassium (K^{+}) status[5].Depending on the soil around 98 % of total soil K was found in unavailable form [6]. As theconversion process of unavailable to available K is a very slow process and not sufficient toreplenish the dearth of available potassium in crop growing season, soil microorganisms canplayasignificantroleinsolubilizationprocessthroughacidolysis,productionoforganicacids,chelation, complexolysis,and ion-exchangereactions[7].

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Keeping in view high import of potassic fertilizers to India and its monetary burden oneconomy,highpotassiumdemandbysweetcorn,sufficiencyofsoilpotassiumbutinunavailable form and considerable potential of ~~KSB~~PSB in converting un-available soil potassiumandmakingitavailabletothecrop,therewasaurgentneedtoassessandquantifytheefficacyof~~KSB~~PSBinpotassiummanagement*vis-à-vis*minimizingchemicalfertilizersrequirementin*rabi*sweetcorn.

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2. MATERIALSANDMETHODS

A field experiment was conducted during *rabi*season (November- February) (2022-23)atCollegefarmofProfessorJayashankarTelanganaStateAgriculturalUniversity,Rajendranagar, Hyderabad, India (17° 19' 18" N latitude, 78° 24' 31" E longitude, with anelevationof542.6mabovemeansealevel)whichisundersemi-aridtropicregion(SAT).Thesoil(p^{H}=7.45)wassandyloamintexture,deficientinsoilorganiccarbonandavailableN,andrichinavailable-Pandavailable-K.Duringthecropgrowthperiod,theweeklymeanmaximumatmospherictemperaturerangedfrom 34.2°Cto28.4°Cwithanaverageof30.4°Candmeanminimum atmospheric temperature ranged from 18.2°C to 10.8°C with an average of 14.7°C(Figure1).

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Comment [Dbf7]: Please mention complete methodology with citations, "How weekly mean maximum and minimum atmospheric temperature was determined?"

The experiment, consisted of 10 potassium management practices, was laid out inrandomizedblockdesignwith3replications.The10treatmentswere-T_1:0%~~RDK~~RDP(Recommendeddoseofpotassium),T_2:100%~~RDK~~RDP(Basal)(50kgha^{-1}),T_3:50%~~RDK~~RDP(Basal)(25 kg ha^{-1}), T_4: 75% ~~RDK~~RDP (Basal) (37.5 kg ha^{-1}), T_5: 50% ~~RDK~~RDP (Basal) + 50% ~~RDK~~RDP [at KneeHeight (KH) stage], T_6: T_1 + ~~KSB~~PSB [Seed Treatment (ST)] + ~~KSB~~PSB [Soil Drenching (SD)] at KHstage,T_7:T_2+~~KSB~~PSB(ST)+~~KSB~~PSB(SD)atKHstage,T_8:T_3+~~KSB~~PSB(ST)+~~KSB~~PSB(SD)at KHstage,T_9:T_4+~~KSB~~PSB(ST)+~~KSB~~PSB(SD)atKHstage,T_{10}:T_5+~~KSB~~PSB(ST)+~~KSB~~PSB(SD)at KHstage.Seeds of variety Madhuri were treated with ~~KSB~~PSB (procured from Dept. of Microbiology, PJTSAU) @10 ml kg^{-1} seed and for soil drenching 2.5 ml ~~KSB~~PSB was mixed with 1 L of water. Quantity ofwater used for ~~KSB~~PSB soil drenching was 20 ml water plant^{-1} and the recommended dose offertilizer (RDF) was 200: 60: 50 (N: P_2O_5: K_2O) kg ha^{-1}. Urea, single super phosphate (SSP)and muriate of potash (MOP) were used as sources of N, P and K respectively for soilapplication.Thedatarecordedonvariousparameterswere~~analysed~~analyzedstatisticallydulyfollowingthe techniqueofanalysisofvarianceforrandomizedblock design[8].

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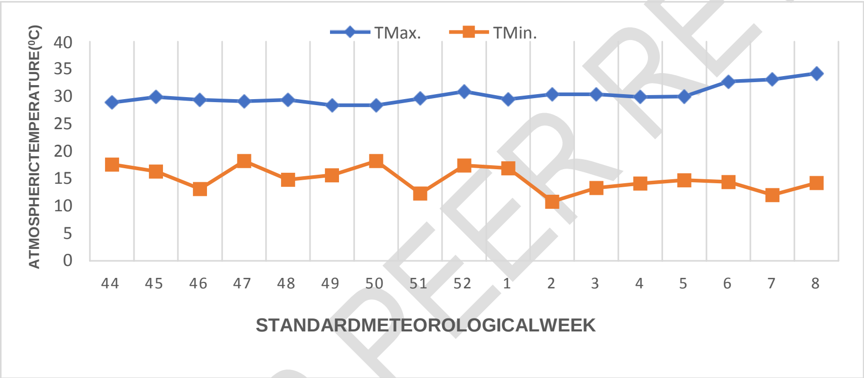

Fig 1.Weeklymaximum andminimumtemperatures(℃)duringthecropgrowthperiod

3. RESULTSANDDISCUSSION

3.1 Growthparameters:

Perusal of the data (Table 1) indicated that numerically highest plant height wasrecorded with T_{10} [50% ~~RDK~~RDP (Basal) + 50% ~~RDK~~RDP at KH stage + ~~KSB~~PSB (ST) + ~~KSB~~PSB (SD) at KHstage]treatmentatdifferentstages.However,atKHstagetherewasnosignificantdifferencein plant height owing to different treatment imposition, except T_1(0% ~~RDK~~RDP) and T_6 [0% ~~RDK~~RDP +~~KSB~~PSB (ST) +~~KSB~~PSB (SD)] treatment. Numerical increment of plant height with increase dose ofpotassiummightbeduetoproperphotosynthesisandcellgrowthwhichisinconsonancewithSwetha et al. [9].

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On the other hand, after KH stage there was some significant changes in leaf areaindex(LAI)anddrymaterduetotreatmentimposition.AtKHstagesignificantlylowerLAIand

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drymater were resulted from T_1 and T_6 treatment but remaining treatment were statistically onper.AtTessellingandHarvestingstagenumericallyhighestLAIanddrymatterwererecordedfrom T_{10}treatment which was on par with T_5, T_2, $T_7$and T_9treatments. Whereas, furtherreductionofpotassiumdoseirrespectiveof~~KSB~~PSBtreatmentresultedinimpairedgrowthin bothstages, however, $T_4$and T_8treatment showed insignificant result and those results weresuperioroverT$_1$,T$_3$andT$_6$treatmentsintermsofLAIanddrymatterproduction.Thesefindingsare in closeagreementwithGnanasundari et al. [10]

Significant improvement of growth parameter due to increment in K-fertilizer or partialsubstitute of ~~RDK~~RDP with ~~KSB~~PSB dose might be attributed to maintenance of cell osmotic pressureand improvement in carbon and nitrogen assimilation and optimization of photosynthesis asreportedby[11][12] [13] [14].

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3.2 Yieldattributes:

Experimentalresult(Table2)revealedthattherewassomesignificantpositiveimpactofKand~~KSB~~PSBoncobweightplant^{-1},Cobgirthandnumberofkernelrow^{-1}whereas,no.ofcobplant^{-1}, cob length, no. of kernel row cob^{-1}were not significantly influenced by differenttreatment. 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 T_{10} over T_1 treatment and T_{10} treatment was on perwithT$_5$,T$_7$,T$_2$andT$_9$treatments.Furthermore,T$_9$i.e.,75%~~RDK~~RDP+~~KSB~~PSB(ST+SD)resulted intostatistically equal impact on change in cob girth, no. of kernels row-1 and cob weight plant-1whencomparedwiththehighesttreatment(T10).Thisindicatedconsiderablepotentialof~~KSB~~PSBin soil and their potential to solubilize soil mineral K into water soluble and exchangeablefractions. Gradual inferiority of yield attributes owing to reduced K application is also alignedwith the findings of [10] in maize in K rich soil. Increment in yield attributes might be resultedfrom optimum () supply of K which might have helped in proper grain filling and translocation ofphotosynthatesfromsourceto sink [15].

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3.3 Yield:

Significantly highest cob yield, green fodder yield were obtained from T_{10}treatmentwhich was statistically similar with T_5 ,T_7, T_2 and T_9 treatments. Eventually harvest index (HI)was also insignificantly influenced byK management practices. It is noteworthy that inbetween basal and 2 equal split applications of 100% ~~RDK~~RDP, letter gave the superior resultirrespectiveof~~KSB~~PSBtreatment.Itsupportsthefindingsof[16].

Thisresultalsoimpliedthat~~KSB~~PSBcouldmake75%~~RDK~~RDP (37.5kgK$_2$Oha^{-1})equivalentto100% ~~RDK~~RDP(50kgK$_2$Oha^{-1})withitspotentialtosolubilize theunavailablesoil-K[17]. Thesefindingsarealsoinaccordancewith[18][10]whereapplicationofKshowedsignificant impactincorn, despitehavinghighinherentsoil-K.

4. Conclusion

It could be concluded that in spite of having high inherent soil-K, it is imperative tosupply 100% ~~RDK~~RDP (50 kg K$_2$O ha^{-1}) to get higher yield. However, partial substitution ofsyntheticKuptotheextentof25%ispossiblebytreatingcornseedwith~~KSB~~PSBfollowedbysoildrenchingatKneeheightstagewithoutcompromisingthepotentialyieldin*alfisols*ofsemiaridtropic.

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Table1:Influenceof PotassiumSolubilizingBacteria(~~KSB~~PSB)ongrowthparametersof*rabi*Sweetcorn.

Treatments	Plantheight(cm)			LAI			Drymatter(kgha^{-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~~RDP	56.4	149.1	168.2	0.31	3.21	3.19	384	6987	14298
T$_2$:100%~~RDK~~RDP(Basal)(50kg ha^{-1})	63.1	180.2	216.4	0.52	4.92	4.81	476	9065	17186
T$_3$:50%~~RDK~~RDP(Basal)(25kgha^{-1})	60.2	174.5	197.3	0.48	3.31	3.28	454	7016	14416
T$_4$:75%~~RDK~~RDP(Basal)(37.5kgha^{-1})	62.1	178.0	202.2	0.51	4.10	4.01	470	8037	15310
T$_5$:50%~~RDK~~RDP(Basal)+50% ~~RDK~~RDP(at KH stage)	60.5	182.2	217.7	0.49	5.00	4.78	455	9185	17210
T$_6$:T$_1$+~~KSB~~PSB (ST)+ ~~KSB~~PSB(SD)atKH stage	57.6	150.6	170.3	0.32	3.29	3.23	395	6994	14325
T$_7$:T$_2$+~~KSB~~PSB (ST)+ ~~KSB~~PSB(SD)atKH stage	63.8	180.6	218.1	0.53	4.95	4.88	480	9110	17195
T$_8$:T$_3$+~~KSB~~PSB (ST)+ ~~KSB~~PSB(SD)atKH stage	61.5	175.4	198.4	0.50	3.89	3.82	465	7990	14913
T$_9$:T$_4$+~~KSB~~PSB(ST)+ ~~KSB~~PSB(SD)atKH stage	62.5	179.8	213.6	0.52	4.52	4.48	472	8987	16378
T$_{10}$:T$_5$+ ~~KSB~~PSB(ST)+~~KSB~~PSB (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**

Table2:Influenceof Potassium SolubilizingBacteria(~~KSB~~PSB PSB)onyieldattributesof*rabi*Sweetcorn.

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Treatments	**Yieldattributes**					
	Cobs plant^{-1}	**Cob weightplant^{-1}(g)**	**Cob length(cm)**	**Cobgirth(cm)**	**Number ofkernel rowscob^{-1}**	**Number ofkernelsrow^{-1}**
T_1:0%~~RDK~~RDP	1.8	212.3	15.2	3.3	13.1	22.4
T_2:100%~~RDK~~RDP(Basal)(50kg ha^{-1})	1.7	295.6	16.3	5.3	13.7	30.5
T_3:50%~~RDK~~RDP(Basal)(25kgha^{-1})	1.7	215.2	15.4	3.4	13.2	23.0
T_4:75%~~RDK~~RDP(Basal)(37.5kgha^{-1})	1.7	251.2	15.8	4.3	13.5	26.8
T_5:50%~~RDK~~RDP(Basal)+50% ~~RDK~~RDP (at KH stage)	1.8	295.4	16.6	5.4	13.6	22.8
T_6:T_1+~~KSB~~PSB (ST)+ ~~KSB~~PSB(SD)atKH stage	1.7	214.6	15.4	3.4	13.1	20.9
T_7:T_2+~~KSB~~PSB (ST)+ ~~KSB~~PSB(SD)atKH stage	1.7	297.6	16.5	5.4	13.8	31.7
T_8:T_3+~~KSB~~PSB (ST)+ ~~KSB~~PSB(SD)atKH stage	1.7	244.5	15.7	4.1	12.9	25.9
T_9:T_4+~~KSB~~PSB(ST)+ ~~KSB~~PSB(SD)atKH stage	1.8	289.5	16.1	4.8	13.3	29.1
T_{10}:T_5+ ~~KSB~~PSB(ST)+~~KSB~~PSB(SD)atKH 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**

Table3:InfluenceofPotassiumSolubilizingBacteria(~~KSB~~PSB)onyieldofrabiSweetcorn.

Treatments	Green cobyield(t ha^{-1})	Greenfodder yield(t ha^{-1})	HarvestIndex(HI)
T$_1$:0%~~RDK~~RDP	15.1	17.9	45.8
T$_2$:100%~~RDK~~RDP(Basal)(50kg ha^{-1})	19.1	22.2	46.2
T$_3$:50%~~RDK~~RDP(Basal)(25kgha^{-1})	15.5	18.3	45.9
T$_4$:75%~~RDK~~RDP(Basal)(37.5kgha^{-1})	16.1	18.8	46.1
T$_5$:50%~~RDK~~RDP(Basal)+50% ~~RDK~~RDP(atKH stage)	19.5	22.6	46.3
T$_6$:T$_1$+~~KSB~~PSB(ST)+ ~~KSB~~PSB(SD)atKHstage	15.2	17.9	45.9
T$_7$:T$_2$+~~KSB~~PSB(ST)+ ~~KSB~~PSB(SD)atKHstage	19.3	22.4	46.3
T$_8$:T$_3$+~~KSB~~PSB(ST)+ ~~KSB~~PSB(SD)atKHstage	15.8	18.5	46.1
T$_9$:T$_4$+ ~~KSB~~PSB (ST)+~~KSB~~PSB(SD)atKHstage	18.0	20.9	46.3
T$_{10}$:T$_5$+~~KSB~~PSB(ST)+~~KSB~~PSB(SD)at KHstage	19.7	22.8	46.4
SEm±	**0.8**	**0.9**	**0.4**
CD(p=.05)	**2.2**	**2.6**	**1.2**