

Original Research Article

<https://doi.org/10.20546/ijcmas.2017.606.023>

Effect of Different Sources and Levels of Potassium on Yield, Nutrient Requirement and Nutrient Use Efficiency by Maize Crop (*Zea mays* L.) in Low K Soils of Eastern Dry Zone of Karnataka, India

Sidharam Patil* and P.K. Basavaraja

Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, GKVK, Bangalore 560065, India

*Corresponding author

ABSTRACT

Keywords

Maize,
Potassium
schoenite,
Potassium
recovery efficiency,
Agronomic
efficiency

Article Info

Accepted:
04 May 2017
Available Online:
10 June 2017

Two field experiments were conducted at Saslu and Sothenhalli village of Dodballapur taluk, Bangalore rural district during Kharif 2014 and 2015 in low K soils with different sources and levels of K application. There was an increase in grain and stover yield with increase in levels of K application and significantly higher grain (77.45 q ha^{-1}) and stover yield (116.38 q ha^{-1}) was recorded in 125% K through potassium schoenite applied treatment. Similarly, higher agronomic efficiency of N (26.42 kg kg^{-1}), P (52.84 kg kg^{-1}) and K (79.25 kg kg^{-1}), higher potassium recovery efficiency (172.94%) and higher nutrient requirement of N (1.63 kg q^{-1}), P (0.38 kg q^{-1}) and K (0.54 kg q^{-1}) were recorded in 125% of K applied through potassium schoenite.

Introduction

Maize or corn (*Zea mays*) called as “queen of cereals” is a versatile plant belonging to the family of grasses (Poaceae). It is cultivated globally being one of the most important cereal crops worldwide. Maize is not only an important human nutrient, but also a basic element of animal feed and raw material for manufacture of many industrial products. The products include corn starch, maltodextrins, corn oil, corn syrup and products of fermentation and distillation industries. Recently it is also being used as a bio fuel. Worldwide production of maize was more than 960 million metric tonne in 2013-14, in

which India contributes about 2 per cent of world maize production (14 metric tonnes). State wise Karnataka stands first in maize production (4.4 metric tonnes) (Anonymous, 2014).

Maize has a high production potential as an exhaustive crop for potassium fertilizer when compared to any other cereal crop. Productivity of maize largely depends on its nutrient requirement. Large quantity of potassium will be taken up by maize crop, which accounts more than $400 \text{ kg K}_2\text{O ha}^{-1}$ under intensive cropping system (Kusro *et al.*,

2014). On the other hand, India ranks fourth after USA, China, and Brazil as far as the total consumption of K-fertilizers in the World is concerned (FAI, 2007). But, there is no reserve of K-bearing minerals in India for production of commercial K-fertilizers and the whole consumption of K-fertilizers are being imported in the form of muriate of potash (KCl) and sulphate of potash (K₂SO₄) which leads to a huge amount of foreign exchange. These necessitate finding an alternate indigenous source of K for plant needs and maintaining K status in soils for sustaining crop production.

Bio-K, a brown coloured powder is a value added product of distillery industry, where untreated spentwash is spray dried at high temperature. It retains most of the nutrients of spentwash and has very high potassium content (11.15% of K₂O). Similarly, potassium schoenite, a double sulfate of potassium and magnesium is made by physical extraction method or by direct removing impurities either from salt lake bittern or solid potassium – magnesium salt mine containing 22% of K₂O. These two K fertilizers in comparison with muriate of potash which contains about 60% of K₂O were used in the present study to know the effect of these three sources of K on yield, nutrient requirement and nutrient use efficiency by maize crop.

Materials and Methods

Field experiments were conducted to study the response of maize to different sources and levels of potassium in low K soils (97.20 and 112.80 kg K₂O ha⁻¹) in two farmer's field at Saslu (Site-1) and Sothenhalli (Site-2) villages of Dodaballapur taluk, Bangalore Rural district during 2014-15 and 2015-16, respectively. Fields were located at 13° 24' 27.5'' N latitude, 77° 23' 11.3'' E longitude and 13° 23' 16.7'' N latitude, 77°34' 45.5'' E

longitude. The experiment was laid out in Factorial Randomized Complete Block Design with one control (FRCBD with one control) and with thirteen treatments comprising of varied levels of potassium (K₂O) viz., 0, 50, 75, 100 and 125 per cent dose of the package of practice of UAS, Bangalore (150 N: 75 P₂O₅: 40 K₂O kg ha⁻¹). The amount of K fertilizer applied for each treatment was calculated as per the per cent K₂O present in different K fertilizers i.e., MOP (60 %), Bio-K (11.15 %) and Potassium schoenite (22 %). Fertilizer N, P, ZnSO₄ (10 kg ha⁻¹) and FYM (10 t ha⁻¹) were applied in common to all the treatments. The pooled data over 2 years were analyzed statistically following standard procedure as described by Gomez and Gomez (1984).

Nutrient requirement (NR): The efficiency of maize crop was calculated in the form of NPK nutrients required (NR) to produce a quintal of grain by using the following formula (Anonymous, 2008).

$$NR \text{ (kg q}^{-1}\text{)} = \frac{\text{Uptake of N/P/K by grain (kg ha}^{-1}\text{)}}{\text{Grain yield (q ha}^{-1}\text{)}}$$

Different nutrient use efficiencies i.e., Agronomic efficiency of nitrogen, phosphorus and potassium were calculated by using the following formula.

$$\text{Agronomic efficiency (N/P/K) (kg kg}^{-1}\text{)} = \left\{ \frac{\text{Grain yield (kg) in K applied plot} - \text{Grain yield (kg) in control}}{\text{Kg of nutrient applied (K)}} \right\}$$

Apparent recovery efficiency/ Recovery efficiency of potassium was calculated based on unit increase in uptake of nutrient over control per unit application of nutrient (Fageria, 1992).

$$\text{Recovery efficiency of potassium} = \left\{ \frac{\text{Total uptake in treatments with K application} - \text{Total uptake in control}}{\text{Kg of nutrient applied}} \right\} \times 100$$

REK (kg kg⁻¹)

Results and Discussion

Grain and stover yield

Irrespective of K levels, significant difference in grain yield of maize was recorded due to different sources of K. Significantly higher grain and stover yield of 63.29 q ha⁻¹ and 95.01 q ha⁻¹, respectively were recorded in potassium schoenite (S2) applied treatment compared to that in MOP (S1) and Bio-K (L2) applied treatment. On the other hand, among the different levels of K applied, irrespective of K sources, there was an increase in grain and stover yield parallel to increase in levels of K applied with significantly higher grain and stover yield of 70.99 q ha⁻¹ and 105.58 q ha⁻¹, respectively in 125% of K (L4) applied treatment compared to all other levels of K applied. Among the interaction between different sources and levels of K, significantly higher grain and stover yield of 77.45 q ha⁻¹ and 116.38 q ha⁻¹, respectively was recorded in 125% of K applied through potassium schoenite (S2L4) compared control and all other treatments except 125% Bio-K with 71.98 q ha⁻¹ of grain yield and 100% potassium schoenite in case of stover yield (107.00 q ha⁻¹) which were statistically on par (Table 2).

Increase in growth and yield parameter with increased levels of K application might be due to increased physiological processes by better utilization of applied NPK fertilizers by maize crop leading to higher plant growth and increased photosynthates to silk as the translocation and accumulation of photosynthates depends upon the efficient photosynthetic structure as well as extent of translocating it into sink (grain) and also on

plant growth and development during early stage of crop growth (Arun kumar *et al.*, 2007).

Increased grain and stover yield in 125% K through potassium schoenite compared to that of MOP and Bio-K as source of K, might be due to S content in the potassium schoenite which might have increased nitrogen assimilation thereby increasing grain and stover yield. The results are in conformity with those of Manjunath (2011), who found increase in growth and yield parameters of rice crop in patent kali (K₂SO₄. MgSO₄) applied plot which resulted in higher grain and straw yield and it was attributed to increased rate of photosynthesis and translocating it to sink (grain). Similarly, increase in grain and stover yield of maize crop with higher levels of sulphur application was reported by Channabasamma *et al.*, (2013) and it was attributed to greater rate of cell division, nitrogen assimilation and chlorophyll formation.

Nutrient requirement (NR)

The individual nutrient required in kg's to produce a quintal of grain (NR) is the indirect method of calculating the nutrient use efficiency (NUE) of a crop. NPK nutrients required to produce a quintal of maize is presented in table 1.

Nitrogen required (kg) to produce a quintal of grain was higher (1.63 kg q⁻¹) in 125% of K applied through potassium schoenite and Bio-K followed by 1.62 and 1.60 kg q⁻¹ in 125% MOP and 75% of K through potassium schoenite, respectively. However, lower (1.55 kg q⁻¹) nitrogen requirement was recorded in control and 100% of K through MOP applied plot. Whereas, phosphorus required (kg) to produce a quintal of grain was higher (0.39 kg q⁻¹) in 125% of K applied through Bio-K followed by 0.38 kg q⁻¹ in 50% K through

MOP and 125% K through potassium schoenite. However, lower (0.36 kg q⁻¹) phosphorus requirement was recorded in control and 100% K through Bio-K treatment and potassium required (kg) to produce a quintal of grain was higher (0.55 kg q⁻¹) in 125% of K applied through MOP followed by 0.54 kg q⁻¹ in 100% MOP, 125% potassium schoenite and 75% Bio-K applied plot. However, lower (0.51 kg q⁻¹) potassium requirement was recorded in control and 100% K through Bio-K treatments.

The perusal of the data of present study clearly indicated that nutrient required (N, P and K) to produce a quintal of grain followed

N>K>P order. The higher NPK requirement of 1.63, 0.38 and 0.54 kg q⁻¹, respectively was recorded in 125% K through potassium schoenite applied plot, where significantly higher grain yield was recorded. This might be due to more utilization of nutrients by the crop for higher yield due to application of higher doses in low potassium soils in the study area compared to low levels of fertilizer application, because of easy availability of nutrients at higher doses. Similar results were supported by Santhosha (2013), who observed higher nutrient requirement in STCR approach, where higher yield of maize was recorded.

Table.1 Effect of different sources and levels of potassium application on nutrient requirement of N, P and K (kg kg⁻¹) (pooled over 2 years)

Treatment	NR _N (kg kg ⁻¹)	NR _P (kg kg ⁻¹)	NR _K (kg kg ⁻¹)
S ₁ L ₁ : 50% K (MOP)	1.56	0.38	0.52
S ₁ L ₂ : 75% K (MOP)	1.56	0.37	0.52
S ₁ L ₃ : 100% K (MOP)	1.55	0.37	0.54
S ₁ L ₄ : 125% K (MOP)	1.62	0.38	0.55
S ₂ L ₁ : 50% K (Pot. schoenite)	1.56	0.37	0.52
S ₂ L ₂ : 75% K (Pot. schoenite)	1.60	0.37	0.52
S ₂ L ₃ : 100% K (Pot. schoenite)	1.57	0.37	0.53
S ₂ L ₄ : 125% K (Pot. schoenite)	1.63	0.38	0.54
S ₃ L ₁ : 50% K (Bio-K)	1.58	0.37	0.52
S ₃ L ₂ : 75% K (Bio-K)	1.58	0.37	0.54
S ₃ L ₃ : 100% K (Bio-K)	1.57	0.36	0.51
S ₃ L ₄ : 125% K (Bio-K)	1.63	0.39	0.54
S ₀ L ₀ : Control (No-K)	1.55	0.36	0.51

Table.2 Effect of different sources and levels of potassium on grain and stover yield (q ha⁻¹) of maize crop (pooled over 2 years)

Treatments	Grain yield (q ha ⁻¹)			Stover yield (q ha ⁻¹)		
	<i>Kharif</i> 2014	<i>Kharif</i> 2015	Pooled	<i>Kharif</i> 2014	<i>Kharif</i> 2015	Pooled
S₁: MOP	53.73	55.87	54.80	83.23	87.47	85.35
S₂: Pot. Schoenite	62.12	64.45	63.29	92.88	97.13	95.01
S₃: Bio-K	58.30	61.70	60.00	84.68	91.86	88.27
SEm_±	1.75	1.19	1.05	3.05	2.18	2.17
CD @5%	5.10	3.47	2.96	8.91	6.35	6.12
L₁: 50 % K	45.25	50.77	48.01	65.22	80.11	72.66
L₂:75 % K	53.24	54.50	53.87	73.18	87.87	80.53
L₃:100 % K	64.19	64.96	64.58	100.98	97.80	99.39
L₄:125 % K	69.52	72.46	70.99	108.33	102.84	105.58
SEm_±	2.02	1.37	1.21	3.53	2.51	2.50
CD @5%	5.88	4.00	3.42	10.29	7.34	7.07
S₁L₁: 50% K (MOP)	42.60	48.19	45.40	63.30	75.72	69.51
S₁L₂: 75% K (MOP)	52.43	51.11	51.77	72.41	86.74	79.58
S₁L₃: 100% K (MOP)	58.18	58.77	58.48	93.54	93.44	93.49
S₁L₄: 125% K (MOP)	61.70	65.41	63.56	103.66	93.99	98.82
S₂L₁: 50% K (Pot. schoenite)	47.20	52.95	50.08	67.37	82.63	75.00
S₂L₂: 75% K (Pot. schoenite)	55.63	58.25	56.94	73.64	89.66	81.65
S₂L₃: 100% K (Pot. schoenite)	68.48	68.88	68.68	112.85	101.14	107.00
S₂L₄: 125% K (Pot. schoenite)	77.18	77.72	77.45	117.66	115.11	116.38
S₃L₁: 50% K (Bio-K)	45.95	51.15	48.55	64.98	81.96	73.47
S₃L₂: 75% K (Bio-K)	51.65	54.15	52.90	73.50	87.23	80.36
S₃L₃: 100% K (Bio-K)	65.91	67.24	66.57	96.55	98.84	97.69
S₃L₄: 125% K (Bio-K)	69.70	74.26	71.98	103.67	99.42	101.54
S₀L₀: Control (No-K)	36.68	38.96	37.82	41.82	53.92	47.87
SEm_±	3.49	2.38	2.10	6.11	4.35	4.33
CD @5%	10.19	6.94	5.92	17.82	12.71	12.25

*S- Source, L- Levels of K, (N, P, ZnSO₄ and FYM were applied as per package of practice to all the treatments)

Table.3 Effect of different sources and levels of potassium application on agronomic efficiency of N, P and K and recovery efficiency of K (pooled over 2 years)

Treatment	Agronomic efficiency (kg kg ⁻¹)			REK (%)
	AEN	AEP	AEK	
S₁L₁: 50% K (MOP)	5.05	10.10	37.88	102.92
S₁L₂: 75% K (MOP)	9.30	18.60	46.51	115.95
S₁L₃: 100% K (MOP)	13.77	27.54	51.64	126.31
S₁L₄: 125% K (MOP)	17.16	34.32	51.47	123.55
S₂L₁: 50% K (Pot. schoenite)	8.17	16.34	61.29	144.69
S₂L₂: 75% K (Pot. schoenite)	12.74	25.49	63.72	138.77
S₂L₃: 100% K (Pot. schoenite)	20.57	41.15	77.15	168.55
S₂L₄: 125% K (Pot. schoenite)	26.42	52.84	79.25	172.94
S₃L₁: 50% K (Bio-K)	7.16	14.31	53.67	134.33
S₃L₂: 75% K (Bio-K)	10.06	20.11	50.28	131.64
S₃L₃: 100% K (Bio-K)	19.17	38.34	71.88	145.17
S₃L₄: 125% K (Bio-K)	22.77	45.54	68.31	136.91
S₀L₀: Control (No-K)	--	--	--	--

Nutrient use efficiency

Nutrient use efficiency (NUE) is critically important concept in the evaluation of crop production systems. It can be greatly impacted by fertilizer nutrient management as well as by soil-plant-water management. The objective of nutrient use is to increase the overall performance of cropping systems by providing economically optimum nourishment to the crop while minimizing nutrient losses from the field.

Among the different sources and levels of K applied, higher agronomic efficiency of N (Table 3) was recorded in potassium schoenite plots with 50 to 125% K *i.e.*, 8.17, 12.74, 20.57 and 26.42 kg kg⁻¹ compared to that in Bio-K and MOP applied plots. Similarly, higher agronomic efficiency of P was recorded in potassium schoenite plots *i.e.*, 16.34, 25.49, 41.15 and 52.84 kg kg⁻¹ at 50, 75, 100 and 125% of K, respectively compared to MOP and Bio-K applied plots and agronomic potassium efficiency was also recorded higher in potassium schoenite plots *i.e.*, 61.29, 63.72, 77.15 and 79.25 kg kg⁻¹

compared to that in Bio-K applied plots at 50, 75, 100 and 125 % of K applied, respectively.

Increasing trend of agronomic efficiency of N, P and K in potassium schoenite applied plots with 125% of K might be due to better availability of N, P and K to crop with corresponding increase in uptake of N, P and K from low K soils. The results are in line with Atheefa Munaware (2007) who found increase in agronomic efficiency of maize crop at initial levels of K applied up to 150% of K application, later it decreased with increase in levels of K.

Recovery efficiency of potassium (REK)

Apparent recovery efficiency of K was higher (172.94%) in 125% of K applied through potassium schoenite, where higher grain and stover yield of maize was recorded. Moreover, this apparent recovery efficiency has increased with increase in levels of K applied where potassium schoenite was applied. But, similar trend was not observed in MOP and Bio-K applied plots. Among the sources and levels of K, higher amount of

apparent recovery of potassium was recorded in potassium schoenite applied plots when compared to that of Bio-K and MOP applied plots at respective levels (50% to 125%) of K application.

This trend should not be surprising, since the higher nutrient requirements of crops at high yield levels is likely to exceed the nutrient supplying ability of unfertilized/lower fertilized soils to a greater extent than at lower yield levels. This increases the difference between the yield of highly fertilized crop and the yield of unfertilized/lower fertilized crop in low K containing soils. Additionally, a crop like maize with a faster nutrient accumulation rate may reduce the potential for nutrient losses from the production field. (Anon., 2014)

In conclusion, this study clearly indicated that the K level can be increased 25% higher than the RDF for maize crop for getting higher yield. Similarly, among the sources, potassium schoenite was found to be best source for realising higher yield of maize crop. So, application of 125 % K through potassium schoenite is beneficial for not only getting higher yield, but also for better agronomic efficiency of applied N and K fertilizers and higher potassium recovery in low K soils of Eastern dry zone of Karnataka.

References

- Anonymous, 2008, Annual progress Report, AICRP on soil test crop response correlation UAS, Bangalore, pp: 23.
- Anonymous, 2014, Nutrient/Fertilizer Use Efficiency: Measurement, Current Situation and Trends. IFA, IWMI, IPNI and IPI.
- Arun Kumar, M. A., Gali S. K. and Hebsur, N. S., 2007, Effect of different levels of NPK on growth and yield parameters of sweet corn. Karnataka J. Agric. Sci., 20(1): 41-43.
- Atheefa Munawery., 2013, Status and revalidation of potassium requirement for finger millet-maize cropping sequence in Eastern dry zone of Karnataka. Ph. D. Thesis, University Agricultural Sciences, Bangalore.
- Channabasamma. A., Habsur, N. S., Bangaremma, S. W. and Akshaya, M. C., 2013, Effect of nitrogen and sulphur levels and ratios on growth and yield of maize. Molecular Pl. Breeding, 4(37): 292-296.
- Fageria, N. K., 1992, Maximizing crop yields, New York; pp 142.
- FAI, 2007, Fertilizer Statistics. The Fertilizer Association of India, New Delhi.
- Gomez, K. A. and Gomez, A. A., 1984, Statistical Procedures for Agric. Res. 2nd Ed. John Wiley & Sons, New York.
- Manjunatha., 2011, Main and residual effect of graded levels of potassium with or without magnesium and sulphur on yield and soil nutrient status in rice-cowpea system, M.Sc.(Agri.) Thesis, Univ. Agri. Sci., Bangalore.
- Kusro, P. S., Singh, D. P., Deepak Kumar and Manish Arya, 2014, American International Journal of Research in Formal, Appl. Nat. Sci., 5(1): 81-82.
- Santhosha, V. P., 2013, Yield maximization in maize through different forms of fertilizers and approaches of nutrient recommendations. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Bangalore.

How to cite this article:

Sidharam Patil and Basavaraja P.K. 2017. Effect of Different Sources and Levels of Potassium on Yield, Nutrient Requirement and Nutrient Use Efficiency by Maize Crop (*Zea mays* L.) in Low K Soils of Eastern Dry Zone of Karnataka, India. *Int.J.Curr.Microbiol.App.Sci.* 6(6): 193-199.

doi: <https://doi.org/10.20546/ijcmas.2017.606.023>