Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(1): 1583-1586
Received: 05-01-2019
Accepted: 10-02-2019

Sunil Kumar Dadhich
Division of Soil Science and Agricultural Chemistry, Rajasthan Agricultural Research Station (Sri Karan Narendra Agriculture University, Jobner), Durgapura, Rajasthan, India

Shanti Kumar Sharma
Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

G Ravindra Charry
AICRPDA, Central Research Institute for Dryland Agriculture, Hyderabad, Telangana, India

Corresponding Author:
Sunil Kumar Dadhich
Division of Soil Science and Agricultural Chemistry, Rajasthan Agricultural Research Station (Sri Karan Narendra Agriculture University, Jobner), Durgapura, Rajasthan, India

Effect of potassium and magnesium on nutrient uptake by maize (*Zea mays* L.) under Dryland conditions

Sunil Kumar Dadhich, Shanti Kumar Sharma and G Ravindra Charry

Abstract
Potassium (K) and magnesium (Mg) are essential plant nutrients responsible for mitigation of biotic and abiotic stresses as well as enhancement in yield of maize. Imbalanced use of fertilizers, erratic rainfall and periodic dry spells are major constraints of low productivity of maize under rainfed conditions. A field experiment was conducted at All India Coordinated Research Project on Dryland Agriculture, Dryland Farming Research Station, Bhilwara, (MPUAT, Udaipur) Rajasthan for continuous four years at fixed site during *Kharif* seasons of 2014, 2015, 2016 and 2017. The experiment comprised of 4 potassium levels; K_0 (0 kg K_2O/ha), K_{20} (20kg K_2O/ha), K_{40} (40 kg K_2O /ha) and K_{60} (60 kg K_2O/ha) and 4 magnesium levels; Mg_0 (0 kg $MgSO_4.7H_2O$/ha), Mg_1 (15 kg $MgSO_4.7H_2O$/ha), Mg_2 (30 kg $MgSO_4.7H_2O$/ha) and Mg_3 (45 kg $MgSO_4.7H_2O$/ ha). Total 16 treatment combinations were tested in factorial randomized block design with three replications. Maize variety PM-3 was taken as a test crop. Application of K and Mg exerted significant effect in increasing nutrients uptake by maize. The uptake of N, P, K and Mg by grain and stover of maize was observed to be highest with the application of K @ 60 kg K_2O/ha which was statistically at par with K application @ 40 kg K_2O/ha. Further, the uptake of N, P, K and Mg was recorded to be maximum under the treatment receiving Mg application @ 45 kg $MgSO_4$/ha standing statistically at par with that under Mg application @ 30 kg $MgSO_4$/ha. Therefore, application of 40 Kg K_2O and 30 Kg $MgSO_4.7H_2O$/ha are found to be beneficial to get higher uptake of nutrients by maize.

Keywords: Dryland farming, potassium, magnesium, maize and uptake

Introduction
Maize (*Zea mays*) the American Indian word for corn means literally “that which sustains life”. Maize is emerging as an important world cereal crop after wheat and rice, which is considered as “Queen of Cereals”. It serves as basic raw materials for production of starch, oil, alcoholic beverages. It is a good source of carbohydrates, fat, protein and some important vitamins and minerals, but deficient in essential amino acids *viz.*, lysine and tryptophan that reduces its biological value (Jaliya *et al*., 2008) [5].
Among the modern cultivation practices, sowing method and fertilizer application are imperative for boosting the growth and production of maize, specially under dryland conditions. Considerable work has been reported on these aspects but efforts are still required to improve these techniques for getting maximum yield.
Potassium is an essential nutrient and is also the most abundant cation in plants. It plays essential roles in sugar translocation, enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomata movement, energy transfer, phloem transport, cation-anion balance, and stress resistance. A major limitation for plant growth and crop production under rainfed condition is soil water availability. Plants that are continuously exposed to drought stress can form reactive oxygen species (ROS), which leads to leaf damage and, ultimately, decreases crop yield. During drought stress, root growth and the rates of K^+ diffusion in the soil towards the roots are both restricted limiting K acquisition. The resulting lower K concentrations can further depress the plant resistance to drought stress, as well as K absorption. Maintaining adequate plant K is therefore, critical for plant drought resistance. A close relationship between K nutritional status and plant drought resistance has been demonstrated earlier (Bashir, 2012) [1]. Magnesium (Mg) is a proportionately important macronutrient, essential for plant growth and is the eighth major plentiful mineral element on earth (Maguire and Cowan, 2002) [8]. Occupying the central location in chlorophyll structure, it is integral to modulating many physiological and biochemical processes including the activation of more than 300 plant growth enzymes such as carboxylases, kinases, phosphatases, ATPases and RNA polymerases (Hawkesford *et al*., 2012) [3]. About three-quarters of leaf Mg content appears to be associated with amino acid and protein synthesis, up to one-fifth with chlorophyll pigments and the

remaining fraction is stored in the vacuole (Karley and White, 2009) [6]. More importantly, three major macronutrients (carbon, nitrogen and sulphur) translocated by the roots are further assimilated in the presence of Mg (Marschner and Rengel, 2009) [9]. However, Mg is known as a hidden secondary plant nutrient. Keeping in the view above facts the current study was conducted with the objective to study the effect of potassium and magnesium on nutrient uptake by maize under dryland condition.

Materials and Methods

A field experiment was conducted at All India Coordinated Research Project on Dryland Agriculture, Dryland Farming Research Station, Bhilwara (Maharana Pratap University of Agriculture and Technology, Udaipur), Rajasthan for continuous 4 years on fixed site during *Kharif* season of 2014, 2015, 2016 and 2017 under dryland conditions. Crop could not form grain during 2015 due to severe long spell drought at the time of flowering and grain filling. The field experiment comprised of 4 potassium levels, K_0 (0 kg K_2O ha^{-1}), K_{20} (20kg K_2O ha^{-1}), K_{40} (40 kg K_2O ha^{-1}) and K_{60} (60 kg K_2O ha^{-1}) and 4 magnesium levels; Mg_0 (0 kg $MgSO_4.7H_2Oha^{-1}$), Mg_1 (15 kg $MgSO_4.7H_2Oha^{-1}$), Mg_2 (30 kg $MgSO_4.7H_2Oha^{-1}$) and Mg_3 (45 kg $MgSO_4.7H_2Oha^{-1}$). Total 16 treatment combinations were tested in factorial randomized block design with three replications. Maize variety PM-3 was taken as a test crop. The soil of the experimental field was Sandy clay loam in texture and slightly alkaline in reaction with pH 7.90, EC 0.27 dSm^{-1} and low in organic carbon 0.37%. The soil was low in available nitrogen (210 kg ha^{-1}), medium in available phosphorus (38 kg ha^{-1}) medium in available potash (331 kg ha^{-1}) and low in exchangeable magnesium (0.81 meq/100 gm soil). The annual rainfall of the region is 600 mm.

Treatments of potassium and magnesium was applied as per the plan at the time of sowing as basal application through muraite of potash and $MgSO_4.7H_2O$, respectively. Basal application of 50Kg N/ha (in two splits) and 30Kg P_2O_5 /ha, common to all the treatments including control was applied at the time of sowing. Representative samples of maize grain and stover were taken at harvest stage, oven dried, ground in Willey mill and analysed for their N, P, K and Mg concentration. Nitrogen content in grain and straw samples was determined by kjeldhal distillation method (Jackson, 1973) [4]. Phosphorus content in grain and straw samples was determined after digestion with triacid and by using vanadomolybdo phosphoric acid yellow color method on spectrophotometer at wavelength of 420nm (Jackson, 1973) [4]. Potassium content of the triacid extract was determined by flame photometer (Jackson, 1973) [4] and magnesium was estimated by Versanate method (Jackson, 1973) [4]. Uptake of nutrients was calculated using nutrient concentrations and grain and straw yield as follows.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%) Yield (kg/ha)}}{100}$$

Result and Discussion

Nutrient uptake

The application of potassium and magnesium significantly improved the uptake of N, P, K and Mg (Table 1 & Figure 1 and 2). The nitrogen uptake in grain straw varied from 26.12to 36.83 kg/ha and 2.82 to 5.89 kg/ha, respectively with the increasing levels of K. The P and Mg uptake also improved with the increasing levels of K. N, P, K and Mg uptake was highest with the application of K @ 60 kg K_2O/ha which was at par with K application @ 40 kg K_2O/ha. Potassium uptake in grain and stover of maize was significantly higher with application of 40 Kg K_2O/ha as compared to control but at par with 20 and 60 kg K_2O/ha.

The increase in N uptake might be due to improved utilization of applied nitrogen in the presence of sufficient potassium (Gnanasundari *et al*., 2018) [2]. These results concur with the results of Ortas (2018) [10], who reported that K fertilizer is crucial to enhancing N uptake by maize genotypes. In case of phosphorus availability of sufficient potassium favoured better root growth and dry matter production and ultimately increased uptake of phosphorus (Kumawat, 2014) [7]. Increase in potassium uptake might have occurred due to more absorption of K with the increase in K concentration in soil.

Increasing levels of Mg application significantly improved N, P, K and Mg uptake in grain and straw of maize. The uptake of N, P, K and Mg in grain and straw was maximum under the treatment receiving Mg application @ 45 kg $MgSO_4.7H_2O$/ha which was at par with Mg application @ 30 kg/ha. The improvement in N and P uptake in maize might be due to the synergistic relation of Mg with these elements in the soil. Magnesium activates enzymes in plants, such as nitrate reductase and sucrose-phosphate synthase, that play imperative role in better utilization of N and portioning of carbon (Zhao *et al*., 2012) [11].

Table 1: Effect of potassium and magnesium on nutrient uptake by maize under dryland conditions (Pooled data)

Treatments	N (kg/ha)		P (kg/ha)		K (kg/ha)		Mg (kg/ha)	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
K_0 (Control)	26.12	2.82	4.48	1.44	8.29	8.38	6.93	22.92
K_{20}	32.15	4.06	5.54	1.83	9.78	10.56	8.47	27.18
K_{40}	36.06	5.19	5.60	2.30	12.81	12.58	9.26	29.31
K_{60}	36.83	5.89	5.70	2.74	14.37	13.59	8.00	30.68
S. Em±	2.10	0.35	0.33	0.19	0.79	0.76	0.51	1.76
C. D. at 5%	4.28	0.71	0.68	0.38	1.61	1.56	1.05	3.60
Mg_0 (Control)	26.47	3.71	4.04	1.54	9.43	9.29	6.27	21.39
Mg_{15}	31.33	4.26	5.47	1.84	10.67	10.63	7.46	25.28
Mg_{30}	35.37	4.79	5.05	2.42	12.23	12.24	8.98	30.16
Mg_{45}	37.98	5.20	5.76	2.51	12.91	12.95	9.95	33.25
S.Em±	2.10	0.35	0.33	0.19	0.79	0.76	0.51	1.76
C.D. at 5%	4.28	0.71	0.68	0.38	1.61	1.56	1.05	3.60

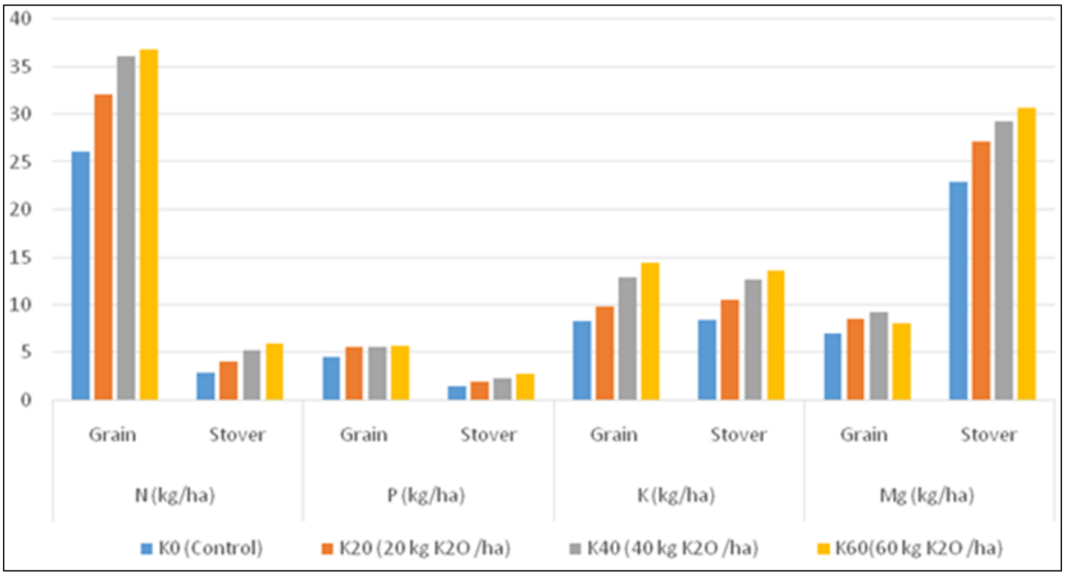

Fig 1: Effect of potassium on uptake of N, P, K and Mg by maize under dryland conditions

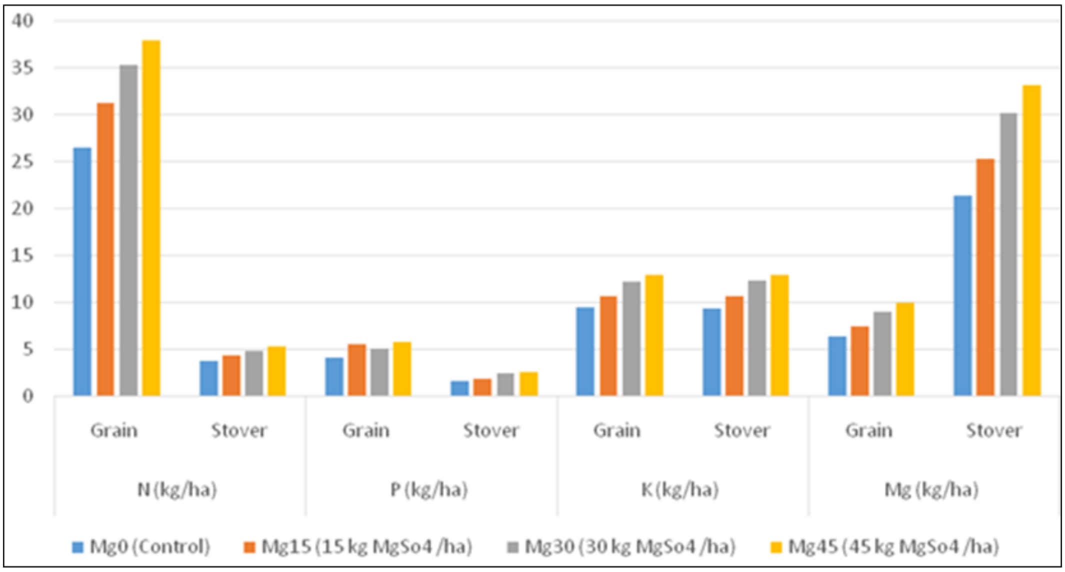

Fig 2: Effect of magnesium on uptake of N, P, K and Mg by maize under dryland conditions

Conclusion

Potassium and magnesium are important essential elements for plants. Further, role of these elements are more important under dryland conditions. It was observed from the results of four years experimentation that highest N, P, K and Mg uptake was recorded with the application of K @ 60 kg K_2O/ha which was at par with that under 40 kg K_2O/ha. The uptake of N, P, K and Mg in grain and stover of maize was maximum in the treatment receiving Mg application @ 45 kg/ha which was at par with Mg application @ 30 kg $MgSO_4.7H_2O$/ha. Therefore, it may be concluded that the application of 40 Kg K_2O and 30 Kg $MgSO_4.7H_2O$/ha are more beneficial doses of K and Mg to get higher nutrients uptake by maize under dryland conditions.

References

1. Bashir S. Response of brown sarson to NPK application under early, normal and late sown conditions (Ph.D. Thesis), Division of Agronomy, SKUAST; c2012.
2. Gnanasundari R, Sellamuthu KM, Malathi P. Effect of potassium on growth, yield and NPK uptake of hybrid maize in black calcareous soil. Madras Agricultural Journal. 2018;106(1-3):32-7. Doi:10.29321/MAJ.2019.000218
3. Hawkesford M, Horst W, Kichey T, Lambers H, Schjoerring J, Moller IS. Functions of macronutrients. In: Marschner P, editor. Marschner's Mineral Nutrition of Higher Plants. UK: Pergamon; c2012. p. 135-189.
4. Jackson ML. Soil chemical analysis. New Delhi: Prentice Hall of India Pvt. Ltd.; c1973.
5. Jaliya MM, Falaki AM, Mahmud M, Abubakar IU, Sani YA. Response of quality protein maize (QPM) (*Zea Mays* L.) to sowing date and NPK fertilizer rate on yield & yield components of quality protein maize. Savannah Journal of Agriculture. 2008;3:24-35.
6. Karley AJ, White PJ. Moving cationic minerals to edible tissues: potassium, magnesium, calcium. Curr. Opin. Plant Biol. 2009;12:291-341.
7. Kumawat P. Effect of nitrogen and phosphorus fertilization on sweet corn (*Zea mays* L. saccharata) varieties. Ph.D. Thesis, MPUAT, Udaipur; c2014. p. 102.
8. Maguire ME, Cowan JA. Magnesium chemistry and biochemistry. Biometals. 2002;15:203-210.
9. Marschner P, Rengel Z. Contributions of rhizosphere interactions to soil. In: Abbott LK, Murphy DV, editors.

Soil biological fertility a key to sustainable land use in agriculture. Dordrecht: Kluwer Academic Publishers; c2009. p. 81-98.

10. Ortas I. Influence of potassium and magnesium fertilizer application on the yield and nutrient accumulation of maize genotypes under field conditions. Journal of Plant Nutrition. 2018;41(3):330-9.
11. Zhao H, Zhou Q, Zhou M, Li C, Gong X, Liu C, *et al*. Magnesium deficiency results in damage of nitrogen and carbon cross-talk of maize and improvement by cerium addition. Biological Trace Element Research. 2012;148(1):102-9.