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Influence of different sources and levels of K fertilizers on soil properties and primary nutrient status in low K soils under maize crop (*Zea mays* L.) in eastern dry zone of Karnataka

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Abstract

Two field experiments were carried out in Saslu and Sothenhalli villages in Eastern dry zone of Karnataka during *Kharif* 2014-15 and 2015-16 in low K soils with different sources and levels of K₂O application. There was no significant difference in soil pH, electrical conductivity and organic carbon content at the harvest of maize crop. Whereas, among the major nutrients significantly higher available phosphorus (26.68 kg ha⁻¹) was recorded during 2015-16 in MOP applied plot. Similarly, significantly higher available potassium (86.60 and 110.05 kg ha⁻¹ during 2014-15 and 2015-16, respectively.) recorded higher in MOP applied plot. However, significantly lower available N and P were recorded at 125% K₂O application. But, significantly higher available K₂O was recorded at 125% of K₂O application. Similarly, among the interactions significantly higher available K₂O was recorded in 125% MOP applied plot. Whereas, significantly higher available N and P were recorded in control plot (No-K) in both the years.

Keywords: Kharif, MOP, potassium schoenite and maize crop

Introduction

Potassium (K), often called as potash, is a key nutrient in soil. It constitutes about 2.5% of the earth's crust, making it the seventh most abundant element and the fourth most abundant mineral nutrient in the lithosphere. Based on the scenario of K fertilizer consumption from past decade it has been considered as the neglected nutrient in the Indian agriculture, as it contributes to less than 10% of the total nutrient consumption in the country. Potassium requirement of crop are in general identical to N and 3-5 times higher than P. However, average K use in India over the last 30 years has been about one-seventh of N and about one third of P. On the other hand, K removal from soil is proportion to N which is very high (Kaushik Majumdar, 2016) [1].

The main reason for less usage of K fertilizers is that, there is no reserve of K-bearing minerals in India for production of commercial K-fertilizers and hence imported in the form of muriate of potash (KCl) and sulphate of potash (K₂SO₄) which costs huge foreign exchange. These necessitate use of an alternate indigenous source of K for plant needs and maintaining K status in soil for sustaining crop production. In this direction, present study has been take up to know influence of different sources *Viz.*, MOP (60% K₂O), Bio-K (11.15% K₂O) and Potassium schoenite (22% of K₂O) and, levels of K fertilizers on soil properties and major nutrient status of soil under maize crop in Eastern dry zone of Karnataka.

Material and methods

Two field experiments were conducted in low K soils of Dodaballapur taluk in farmer's field at Saslu (Site-1) and Sothenhalli (Site-2) villages of Bangalore rural district (Eastern dry zone of Karnataka) during 2014-15 and 2015-16. 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 experiments were laid out in a factorial randomized complete block design with one control i.e., 3 sources and 4 levels of K₂O with one control which were replicated thrice. Farm yard manure (10 t ha⁻¹) was incorporated 15 days prior to sowing, maize seeds were dibbled at a spacing of 60 cm x 30

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cm and recommended dose of N, P and ZnSO₄ (150, 75 and 10 kg ha⁻¹, respectively.) were applied with varied levels of K₂O i.e., 50, 75, 100 and 125 per cent of recommended dose of K₂O as per the package of practice of UAS, Bangalore and as per the treatments at the time of sowing with three different sources of K (MOP, Bio-K and Potassium schoenite). All other recommended agronomic practices were carried out to all treatments uniformly during the course of the study.

Soil samples were collected two times i.e., before sowing and after harvest of the maize crop and were analyzed for soil pH, electrical conductivity, organic carbon, available nitrogen, available phosphorus and available potassium by following the standard procedures as outlined by Jackson, 1973. The soils of the experimental fields were acidic in pH (5.26 and 5.04) and initial physico-chemical properties of soils are presented in table 1.

Results and Discussion

Soil pH

No significant difference in soil pH was recorded among the K sources, levels and there interactions during both the years i.e., 2014-15 and 2015-16 (table 2). However, among the sources slightly higher pH was noticed in MOP (S₁) and potassium schoenite (S₂) treatments (5.22 and 4.99 during 2014-15 and 2015-16, respectively.). Among the levels of K application irrespective of sources 50% K₂O (L₁) recorded higher soil pH (5.22 and 5.01 during 2014-15 and 2015-16, respectively.) and slight decrease in soil pH was noticed with increase in levels of K application. However, among the interactions higher values of soil reaction was noticed with 75% K₂O through potassium schoenite treatment (S₂L₂) (5.23 and 5.01 during 2014-15 and 2015-16, respectively) compared to all other interactions.

Slight decrease in soil pH in all the treatments compared to initial could be ascribed to acidifying effect of urea and organic acids produced during the course of decomposition of organic amendments. The release of H⁺ ions by organic matter depends on initial pH of soil and dissociation constants (pK) of weak organic acids. The association of anions from the organic sources with H⁺ in soil appears to be more important process for pH changes in the soil. Organic matter is usually considered to reduce soil pH by releasing H⁺ ions that are associated with anions or by nitrification process (Anon, 2017) [3]. Similarly, Basumantary and Talukdar (1998) [6] and Srikanth *et al.* (2000) [18] also indicated that addition of varying quantities of inorganic fertilizers in combination of FYM maintained the pH, when compared to fertilizers alone.

Electrical conductivity (EC)

Post harvest soil EC did not show any significant difference among the K sources, levels and there interactions during both the years i.e., 2014-15 and 2015-16 (table 2). But, there was an increase in soil EC over the initial values. Moreover, increasing trend of EC was noticed with increase in levels of K application with higher EC (0.172 and 0.069 dS m⁻¹ during 2014-15 and 2015-16, respectively.) in 125% K₂O (L₄) treatment. Among the interactions higher values of EC were recorded in Bio-K treatment at respective levels of K application from 50 to 125% compared to MOP and potassium schoenite during both the years.

Increase in EC with increased levels of K fertilizer application might be due to slight increase in salt content with increase in levels of inorganic fertilizers. The results are in line with those of Santhy *et al.* (1999) [17] and Atheefa Munawery (2013) [4], they

reported slight increase in the EC over the initial value with higher levels of K fertilizer application after harvest of crop and it was attributed to presence of chloride salts in the MOP fertilizers. On the other hand, due to addition of FYM availability of soluble forms of K, Ca, Mg and Na will be more which lead to formation of some salts and increased soil EC (Gathala *et al.*, 2007) [9]. Whereas, slightly higher EC in Bio-K applied treatment compared to that of MOP and potassium schoenite applied plot at different levels of K it might be due to presence of more soluble salts in Bio-K. Similar results of increased EC in spentwash applied plots at harvest of ragi crop was recorded by Srinivasamurthy *et al.* (2008) [19].

Soil Organic carbon (OC)

There was an increase in soil OC over the initial values when K was applied through different sources, with different levels and there interactions. But, there was no significant difference among them (table 2). However, higher value of OC (0.54 and 0.48% during 2014-15 and 2015-16, respectively.) was recorded in Bio-K (S₃) treatment. Moreover, there was an increasing trend of OC with increase in levels of K application during both the years irrespective of K sources and among the interaction Bio-K treatment recorded higher OC during both the years compared to that of MOP and potassium schoenite treatment plots.

Increase in OC with increase in levels of K through all the sources of K might be due to addition of FYM to all the treatments and increase in root biomass through increased crop yield as the levels of K increased. Babhulkar *et al.* (2000) [5] reported increase in organic carbon in soil due to application of FYM or in combination with fertilizers and attributed to larger biomass production, which aid to increased organic carbon content of soil.

Similarly, increase in OC content in soil due to application of FYM + inorganic fertilizers was recorded by Suresh *et al.* (1999) [22] and Yifter Nega *et al.* (2000) [23] and it was attributed to higher biomass production evidenced from higher yield recorded over the control. Whereas, variation in OC status among the treatments was attributed to differential rate of oxidation of organic matter by the microbes.

Sudhir and Siddaramappa (1995) [20] reported that organic carbon content of an Alfisol increased by 17.8% in plots treated with 100% NPK in the form of fertilizers and by 78.3% in plots treated with FYM plus 100% NPK and it was attributed to increase in microbial activity by application of FYM thereby increasing root biomass which has contributed to higher OC.

Available nitrogen

There was no significant difference in available nitrogen content in soil during 2014-15 and 2015-16 (table 3) among the different sources. However, numerically higher available nitrogen was recorded (285.38 and 312.49 kg ha⁻¹) with application of MOP (S₁). Whereas, significantly higher available nitrogen was recorded with 50% K₂O application (L₁) (293.84 and 322.05 kg ha⁻¹ during 2014-15 and 2015-16, respectively) compared to 125% K₂O (L₄) application (273.32 and 286.55 kg ha⁻¹ during 2014-15 and 2015-16, respectively). But, it was statistically on par with 75% K₂O (L₂) and 100% K₂O (L₃) application. However, among the interactions, control (No K) recorded significantly higher available nitrogen (325.31 and 340.92 kg ha⁻¹ during 2014-15 and 2015-16, respectively.) compared to 125% potassium schoenite treatment (S₂L₄) (268.02 and 282.26 kg ha⁻¹ during 2014-15 and 2015-16, respectively). But, it was statistically on par with 50% K₂O through MOP (S₁L₁) during 2014-15 and 50 and 75% K₂O through all the three sources

during 2015-16.

The lowest available N was observed in the plots treated with potassium schoenite compared to that of MOP and Bio-K irrespective of the level of application. The reason for this could be attributed to higher uptake of N by the crop, consequent to higher crop yield in those plots. The present results are in corroboration with those of Manjunatha *et al.* (2013) [13] who reported that there was decrease in available N content in soil with increase in levels of K application and it was attributed to increase in yield of crop with increase in K application which resulted in higher uptake of N.

Belay *et al.* (2003) [7] found that there was build up in available N in N alone applied plot compared to that in NPK applied plot which declined over the years due to the uptake of N by the maize crop under long term fertilizer experiment. Similarly, Dakshina Murthy *et al.* (2015) [8] found decrease in available N with increase in levels of K application after harvest of rice crop.

Available phosphorus

During 2014-15, non significant difference in available phosphorus content was recorded between different sources of K (table 3), irrespective of levels of K. But, during 2015-16 significantly higher available phosphorus (26.68 kg ha⁻¹) was recorded with application of MOP (S₁) compared to potassium schoenite (S₃) (24.54 kg ha⁻¹). However, it was statistically on par with Bio K (S₃) (25.15 kg ha⁻¹). Among different levels of potassium application significantly higher available phosphorus was recorded with 50% K₂O application (77.70 and 26.58 kg ha⁻¹ during 2014-15 and 2015-16, respectively) compared to 125% K₂O application (70.16 and 24.40 kg ha⁻¹ during 2014-15 and 2015-16, respectively). But, it was statistically on par with 75% K₂O application during both the years and 100% K₂O application during 2014-15. Among the interactions, significantly higher available phosphorus was recorded in control (No K) (79.00 and 28.66 kg ha⁻¹ during 2014-15 and 2015-16, respectively) compared to 125% K₂O through potassium schoenite treatment (67.60 and 23.95 kg ha⁻¹ during 2014-15 and 2015-16, respectively).

Significantly difference in available P content of soil as a result of graded doses of K application with significantly lower available P at 125% level of K₂O application and highest at 50% level of K₂O application through all sources of K *viz.*, MOP, potassium schoenite and Bio-K as observed in case of available N, obviously due to the low crop yields in 50% K₂O applied plots, resulting in low P uptake by the crop. These results are in agreement with those of Patel *et al.* (1985) [15], Lokeswarappa (1997) [12] and Sudhir *et al.* (2004) [21], who reported build up of soil P in plots which were devoid of K (100% NP) and it was attributed to low uptake of applied P in those plots when compared to that in the 100% of NPK applied plots, where higher uptake of P from soil resulted in lower available P.

Available potassium

Among the different sources, irrespective of levels of K applied, significantly higher available K (86.80 kg ha⁻¹) was recorded during 2014-15 in MOP (S₁) treatment compared to potassium schoenite treatment (81.96 kg ha⁻¹). But, it was on par with Bio-K treatment. Among different levels of potassium applications (table 3), significantly higher available potassium was recorded with 125% K₂O application (L₄) (93.20 and 115.16 kg ha⁻¹ during 2014-15 and 2015-16, respectively) compared to other levels of K application during both the years, except 100% K₂O during 2015-16, which was statistically on par. Whereas, among

the interactions, significantly higher available K was recorded when 125% K₂O was applied through potassium schoenite treatment (S₂L₄) (91.60 and 114.00 kg ha⁻¹ during 2014-15 and 2015-16, respectively.) compared to control treatment where K fertilizer was not applied.

In contrast to available N and P contents of the soil, increase in available K content of the soil with increased levels of K application, through all sources of K *viz.*, MOP, potassium schoenite and bio-K. This was obviously due to addition of increased quantity of K to the soil at higher rates, which might have resulted in retention of unused portion of K in the soil itself, after harvest of the crop. These results are in conformity with the findings of Ahmad and Tarence (2016) [2] who found that there was an increase in available K content in soil with increase in levels of K applied after harvest of wheat crop. Moreover, incorporation of organic manure with fertilizer N has increased the cumulative non-exchangeable K release, and maintained greater amounts of potassium in solution and on exchange sites, by re-establishing the equilibrium among the forms of potassium. Similarly, increase in water soluble and exchangeable K with K fertilizer application was recorded earlier in the incubation studies Santosha (2013) [16].

In respect to three different sources of K, the lowest available K due to potassium schoenite at all the four levels of K application could be related to the crop yield which was relatively higher in the plots treated with potassium schoenite at all the four levels of K application. The available K levels were significantly lower in control plot that did not receive K. The present results are in line with those of Sudhir and Siddramappa (1995) [20], who recorded tremendous decrease in soil available K over the years in long term fertilizer experiment under finer millet- maize cropping system in plots which were devoid of K and it was attribute to the uptake of K by the crop over the years. On the other hand, decrease in available K when K was applied in form of K₂SO₄. MgSO₄ (patent kali) after harvest of rice and residual cowpea was noticed by Manjunatha *et al.* (2011) [14] and it was related to the higher yield in those plot which has resulted in decrease in available K when compared to MOP applied plots.

Table 1: Initial physico-chemical properties of soils in study area

Parameters	Site-1	Site-2
Location	Saslu	Sothenahalli
Particle size distribution (%)		
Sand (%)	74.4	68.8
Silt (%)	7.6	9.4
Clay (%)	18.0	21.8
Soil texture	Sandy loam	Sandy clay loam
Bulk density (g cm ⁻³)	1.59	1.52
pH (1: 2.5)	5.26	5.04
EC (dSm ⁻¹)	0.161	0.054
OC (%)	0.46	0.38
CEC (cmol (p ⁺) kg ⁻¹)	8.6	6.71
Available N (kg ha ⁻¹)	298.54	322.38
Available P ₂ O ₅ (kg ha ⁻¹)	72.09	22.18
Available K ₂ O (kg ha ⁻¹)	97.20	112.8
Available S (mg kg ⁻¹)	11.02	8.24
Ca (c mol (p ⁺) kg ⁻¹)	1.75	3.75
Mg (c mol (p ⁺) kg ⁻¹)	0.75	1.50
Zn (mg kg ⁻¹)	1.38	1.27
Mn (mg kg ⁻¹)	8.74	7.68
Fe (mg kg ⁻¹)	14.71	16.37
Cu (mg kg ⁻¹)	0.79	0.83
B (mg kg ⁻¹)	0.57	0.28

Table 2: Effect of different sources and levels of potassium on pH, EC and organic carbon (OC) status of soil after harvest of maize crop

Treatments	Soil pH		Soil EC (dS m ⁻¹)		Soil OC (%)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
S ₁ : MOP	5.22	4.99	0.168	0.065	0.51	0.45
S ₂ : Pot. Schoenite	5.22	4.99	0.169	0.065	0.52	0.46
S ₃ : Bio-K	5.20	4.98	0.171	0.067	0.54	0.48
SEm ₊	0.03	0.04	0.002	0.002	0.01	0.01
CD @5%	NS	NS	NS	NS	NS	NS
L ₁ : 50% K ₂ O	5.22	5.01	0.166	0.062	0.50	0.44
L ₂ :75% K ₂ O	5.22	5.00	0.167	0.064	0.52	0.45
L ₃ :100% K ₂ O	5.21	4.97	0.172	0.067	0.53	0.47
L ₄ :125% K ₂ O	5.20	4.96	0.172	0.069	0.54	0.48
SEm ₊	0.04	0.04	0.002	0.002	0.01	0.02
CD @5%	NS	NS	NS	NS	NS	NS
S ₁ L ₁ : 50% K ₂ O (MOP)	5.21	5.01	0.165	0.062	0.49	0.43
S ₁ L ₂ : 75% K ₂ O (MOP)	5.23	5.00	0.166	0.063	0.50	0.44
S ₁ L ₃ : 100% K ₂ O (MOP)	5.23	4.97	0.170	0.066	0.52	0.46
S ₁ L ₄ : 125% K ₂ O (MOP)	5.21	4.97	0.172	0.067	0.53	0.47
S ₂ L ₁ : 50% K ₂ O (Pot. schoenite)	5.22	5.01	0.165	0.062	0.50	0.44
S ₂ L ₂ : 75% K ₂ O (Pot. schoenite)	5.23	5.01	0.166	0.064	0.51	0.45
S ₂ L ₃ : 100% K ₂ O (Pot. schoenite)	5.20	4.98	0.171	0.065	0.53	0.47
S ₂ L ₄ : 125% K ₂ O (Pot. schoenite)	5.21	4.96	0.172	0.069	0.54	0.48
S ₃ L ₁ : 50% K ₂ O (Bio-K)	5.22	5.01	0.168	0.063	0.52	0.45
S ₃ L ₂ : 75% K ₂ O (Bio-K)	5.20	4.99	0.169	0.064	0.54	0.47
S ₃ L ₃ : 100% K ₂ O (Bio-K)	5.20	4.96	0.173	0.068	0.56	0.49
S ₃ L ₄ : 125% K ₂ O (Bio-K)	5.17	4.95	0.174	0.071	0.57	0.50
S ₀ L ₀ : Control (No-K)	5.20	4.96	0.164	0.059	0.49	0.43
SEm ₊	0.07	0.07	0.004	0.004	0.02	0.03
CD @5%	NS	NS	NS	NS	NS	NS

*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 on available nitrogen, phosphorus and potassium status of soil after harvest of maize crop

Treatments	Available N (kg ha ⁻¹)		Available P ₂ O ₅ (kg ha ⁻¹)		Available K ₂ O (kg ha ⁻¹)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
S ₁ : MOP	285.38	312.49	76.13	26.68	86.80	110.05
S ₂ : Pot. schoenite	279.49	297.60	73.83	24.54	81.98	106.50
S ₃ : Bio-K	282.81	302.11	74.36	25.15	84.98	108.10
SEm ₊	5.25	7.78	0.98	0.43	1.61	1.79
CD @5%	NS	NS	NS	1.27	4.69	5.23
L ₁ : 50% K ₂ O	293.84	322.05	77.70	26.58	75.44	101.22
L ₂ :75% K ₂ O	284.02	309.47	76.52	25.88	83.31	105.78
L ₃ :100% K ₂ O	279.05	298.20	74.72	24.96	86.40	110.71
L ₄ :125% K ₂ O	273.32	286.55	70.16	24.40	93.20	115.16
SEm ₊	6.07	8.98	1.13	0.50	1.86	2.07
CD @5%	17.71	26.21	3.29	1.46	5.42	6.03
S ₁ L ₁ : 50% K ₂ O (MOP)	295.31	331.91	78.15	28.15	77.20	103.27
S ₁ L ₂ : 75% K ₂ O (MOP)	286.74	319.21	77.65	27.45	85.20	108.53
S ₁ L ₃ : 100% K ₂ O (MOP)	281.00	307.07	75.95	25.97	89.20	112.13
S ₁ L ₄ : 125% K ₂ O (MOP)	278.48	291.78	72.78	25.13	95.60	116.27
S ₂ L ₁ : 50% K ₂ O (Pot. schoenite)	292.69	312.75	77.65	25.13	73.20	98.80
S ₂ L ₂ : 75% K ₂ O (Pot. schoenite)	281.00	303.96	76.46	24.79	80.33	103.60
S ₂ L ₃ : 100% K ₂ O (Pot. schoenite)	276.23	291.44	73.62	24.29	82.80	109.60
S ₂ L ₄ : 125% K ₂ O (Pot. schoenite)	268.02	282.26	67.60	23.95	91.60	114.00
S ₃ L ₁ : 50% K ₂ O (Bio-K)	293.53	321.49	77.31	26.46	75.93	101.60
S ₃ L ₂ : 75% K ₂ O (Bio-K)	284.33	305.24	75.45	25.39	84.40	105.20
S ₃ L ₃ : 100% K ₂ O (Bio-K)	279.93	296.11	74.60	24.62	87.20	110.40
S ₃ L ₄ : 125% K ₂ O (Bio-K)	273.46	285.61	70.10	24.12	92.40	115.20
S ₀ L ₀ : Control (No-K)	325.31	340.92	79.00	28.66	73.60	94.80
SEm ₊	10.51	15.56	1.95	0.87	3.21	3.58
CD @5%	30.67	45.41	5.71	2.53	9.38	10.45

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

Conclusion

This study clearly indicates that with increase in levels of K₂O application there was an ample buildup in the available potassium content in soils, even with the initial low available

potassium status in soil. Whereas, there was a decrease in available nitrogen and phosphorus content in soil with increased levels of K₂O application in Eastern dry zone of Karnataka.

References

1. Abdel-Rahman AH. Effect of mineral potassium, compost and biofertilizers on soil physio-chemical properties and productivity of sesame grown on salt affected soils. *J Soil Sci Agric Eng.* 2014;5(6):791-805.
2. Ahmad SS, Tarence T. Effects of different levels of NPK on soil properties by wheat (*Triticum aestivum* L.). *Int J Multidiscip Res Dev.* 2016;3(5):220-223.
3. Anonymous. Long term integrated nutrient management - soil and crop. Bangalore: AICRP on Dryland Agriculture, UAS, GKVK; 2017.
4. Munawary A. Status and revalidation of potassium requirement for finger millet-maize cropping sequence in eastern dry zone of Karnataka [PhD thesis]. Bangalore: University of Agricultural Sciences; 2013.
5. Babhulkar RM, Wandile WP, Badole S, Balpande SS. Residual effect of long-term application of FYM and fertilizers on soil properties (Vertisols) and yield of soybean. *J Indian Soc Soil Sci.* 2000;48:89-92.
6. Basumantary A, Talukdar MC. Long-term effect of integrated nutrient supply on soil properties in an Inceptisol of Assam. *Oryza.* 1998;35(1):43-46.
7. Belay A, Claassens AS, Wehner FC. Effect of direct nitrogen and potassium and residual phosphorus fertilizers on soil chemical properties, microbial components and maize yield under long-term crop rotation. *Biol Fertil Soils.* 2003;35:420-427.
8. Dakshina Murthy KM, Upendra Rao A, Vijay D, Sridhar TV. Effect of levels of nitrogen, phosphorus and potassium on performance of rice. *Indian J Agric Res.* 2015;49:83-87.
9. Gathala MK, Kanthaliya PC, Verma A, Chahar MS. Effect of INM on soil properties and humus fractions in long-term fertilizer experiments. *J Indian Soc Soil Sci.* 2007;55(3):360-363.
10. Jackson ML. Soil chemical analysis. New Delhi: Prentice Hall of India Pvt Ltd; 1973.
11. Majumdar K. Potassium: you cannot overemphasize its importance in Indian agriculture. In: Proceedings of the 81st Annual Convention of ISSS; New Delhi; 2016.
12. Lokeshwarappa C. Distribution of major plant nutrients in an Alfisol subjected to long term fertilizer schedule and crop sequence [MSc thesis]. Bangalore: University of Agricultural Sciences; 1997.
13. Manjunatha B, Narendrababu, Jagadeesh BR, Anil Kumar S, Sudhir K. Effect of potassium, sulphur and/or magnesium on soil nutrient status and yield of rice and residual crop of cowpea. *Mysore J Agric Sci.* 2013;47(2):320-327.
14. Manjunatha. 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 [MSc thesis]. Bangalore: University of Agricultural Sciences; 2011.
15. Patel PV, Mehta PM, Patel ML, Patel MG. Efficient utilization of potassic fertilizers by sorghum on Vertisols. *J Potash Res.* 1985;1(2):129-132.
16. Santhosha VP. Yield maximization in maize through different forms of fertilizers and approaches of nutrient recommendations [MSc thesis]. Bangalore: University of Agricultural Sciences; 2013.
17. Santhy P, Veluswamy MS, Murugappan V, Selvi D. Effect of inorganic fertilizers and FYM combination on soil physico-chemical properties and dynamics of microbial biomass in an Inceptisol. *J Indian Soc Soil Sci.* 1999;47:479-482.
18. Srikanth K, Srinivasamurthy CA, Siddaramappa R, Ramakrishna Parama VR. Direct and residual effects of enriched compost, FYM, vermicompost and fertilizer on properties of an Alfisol. *J Indian Soc Soil Sci.* 2000;48:496-499.
19. Srinivasamurthy CA, Bhaskar S, Balakrishna AN. Utilization of distillery spent wash for agricultural purpose. Bangalore: UAS; 2008. p. 1-37.
20. Sudhir K, Siddaramappa R. Role of organic manure in the maintenance of soil health and productivity: an experience from long term fertilizer experiments at Bangalore centre. In: Shivashankar K, editor. Alternatives to fertilizers in sustainable agriculture. Bangalore: University of Agricultural Sciences; 1995.
21. Sudhir K, Singh MV, Jayaprakash SM. Soil quality, crop productivity and sustainability experiences under long term finger millet-maize cropping in Alfisol. Bhopal: Indian Institute of Soil Science (ICAR); 2004. p. 1-30.
22. Suresh S, Subramanian S, Chitdeshwari T. Effect of long term fertilizer and manures on yield of sorghum-cumbu rotation on Vertisol under dry farming and soil properties. *J Indian Soc Soil Sci.* 1999;47(2):272-276.
23. Yifter N, Srikanth K, Sudhir K. Evaluation of soil test methods for available sulphur in an Alfisol under long term fertilizer experiment. *J Indian Soc Soil Sci.* 2000;34:115-120.