Impact of Sulphate of Potash and Partially Burned Paddy Husk on Soil pH, Electrical Conductivity and Plant Phosphorus Content in Saline Paddy Soil

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Abstract
The productivity of most of the paddy growing lands in Sri Lanka declines due to soil salinity. A pot culture experiment was conducted to study the impact of sulphate of potash (SOP) and partially burned paddy husk (PBPH) on soil pH, electrical conductivity and plant phosphorus content in saline paddy soil. The experiment was of a completely randomize block design in 2 x 4 factorial arrangement. The treatments comprised of two PBPH levels (0 and 625Kg/ha) and four potassium rates (0, 18, 36 and 72 kg K_2O/ ha in the form of sulphate of potash. The results revealed that the combine application decreased soil pH from 7.9 to near neutral among the treatments and ranged from 7.40 - 7.46. Combining PBPH with SOP influenced the soil electrical conductivity favourably and decreased from 7.24 dS/m to ≤4 dS/m. Plant phosphorus concentration increased with increase in the rate of K_2O application in the form of SOP from 0 to 72 kg /ha. Combining PBPH with SOP increased the phosphorus content in plants than non-amended soil. Highest plant phosphorus content was recorded at 72 kg K_2O/ ha application in both amended and non-amended soil; as 4.536 and 3.721 mg/g dry weight, respectively. The results of this study suggested that, by incorporating partially burned paddy husk with sulphate of potash, soil pH, electrical conductivity and phosphorus uptake by rice crop in saline soil can be improved.

Keywords: Partially burnt paddy husk, Phosphorus, Salinity, paddy, Sulphate of potash
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Introduction

Productive soils may be degraded over time due to one or combination of factors. Soil salinity becomes a major issue in global agriculture when soil and environmental factors contribute to the accumulation of salts in soil layers, above a level that adversely affects crop production, and more prominent in environment where scarcity of water and high temperatures prevail. In saline or other problematic soils, the prevailing unfavourable conditions as well as inadequate and imbalanced use of plant nutrients cause a considerable decline in paddy yield.

In addition, low P availability and uptake by plants are major limitations in salt-affected soils (pH>7). Low P availability results from precipitation, transformation, fixation of P with soil minerals and in presence of high amounts of soluble salts. Salinity may also reduce the P flux through the xylem. Increasing P availability and enhancing P nutrition of plants through fertilization and amelioration may enhance plant salt tolerance and growth.

Potassium is an essential macronutrient required for the proper development of plants. Among the available forms of potassium fertilizer, studies indicated that sulphate of potash (50% of K_2O and 18% S) is the most preferred potassium source in salt-affected soils (Abd El-Hadi *et al.*, 2002). Potassium is a quite mobile nutrient in the soil. Although K^+ ion can be retained to some extent by negative charges on clay surfaces, it can be easily displaced into the soil solution by calcium or magnesium ions. Therefore, potassium might not be taken up by plants can be easily lost from the root zone by leaching. Organic materials usually have a high cation exchange capacity, enabling them to retain the potassium ions effectively. Previous studies showed that partially burned paddy husk improved the soil conditions and rice yield components in saline soils. There is a need to improve the productivity of salt-affected paddy lands by using the modified agricultural practices and fertilization methods. Therefore, this study was contemplated to study the impact of partially burned paddy husk and potassium in the form of sulphate of potash on pH and electrical conductivity (EC) of soil and phosphorus availability of plants.

Materials and Methods

A pot culture experiment was conducted during *Yala* season at the Eastern University, Sri Lanka; the experiment was laid out in a completely randomized 2×4 factorial design with three replicates. The treatments comprised of two PBPH levels (0 and 625 Kg/ha) and four potassium rates (0, 18, 36 and 72 kg K_2O/ ha in the form of sulphate of potash. There were eight treatments which consisted of four sole treatments (three rates of K_2O and single rate of PBPH), three treatment combinations (three K_2O

levels combined with PBPH) and a control (without K_2O or PBPH).

Composite soil sample was collected from a saline experimental site and was analyzed for soil pH (8.3), electrical conductivity (EC 19.1 dS/m) and available phosphorus (9.69 mg/kg) content using pH meter (HANNA HI 98130), EC meter (HANNA HI 86303), Olsen's phosphorus method respectively. Available phosphorus (0.12%) content of PBPH was analyzed calorimetrically by using spectrophotometer. Air dried and powdered PBPH was incorporated into the soil according to the treatment combinations. Then it was filled (20 kg) into the bags and kept at the field capacity (FC) for two weeks.

Common basal applications of nitrogen and phosphorus were applied as urea (N 46%), as triple super phosphate (TSP) (P_2O_5 46%) respectively. Potassium was applied in the form of sulphate of potash (K_2O 50%) to each bag just before sowing according to the treatments. Pre soaked paddy seeds (15 seeds) were spread in each poly bag. After two weeks, seedlings were thinned down to ten plants per bag based on the Department of Agriculture recommendation. All the agronomic practices except fertilizer application were followed as suggested by the Department of Agriculture. At the heading stage, whole plants from each treatment were uprooted, cleaned, dried, powdered and analyzed for their phosphorus content. At the end soil was removed, mixed well, air dried and analyzed for its EC and pH by using EC and pH meters. All data were statistically analyzed by analysis of variance (ANOVA) and the mean separation was done using Duncan's Multiple Range Test at 5% level.

Results and Discussion

Soil pH

The statistical scrutiny showed that (Table 1) the potash applications did not significantly influence the soil pH ($p>0.05$). However, combining the PBPH with sulphate of potash significantly influenced the soil pH towards the end of the experiment. Soil pH was decreased from pH 7.9 to 7.4 in amended soil. This might be due to the addition of organic amendment may increase the soil microbial respiration, which may reduce pH by organic acid production during decomposition. The pH was significantly reduced to 7.4 in 72 kg K_2O/ha application and to 7.43 with 36 kg K_2O/ha application. Furthermore, formation of organic acids through the decomposition of PBPH may reduce the pH of soil.

Soil Electrical conductivity

A perusal of the soil electrical conductivity (Table 1) indicated that combining amendment with sulphate of potash significantly influenced the soil electrical conductivity towards the end of the experiment. Soil electrical conductivity was decreased from 7.24 dS/m to ≤4 dS/m. A possible reason could be the improvements in chemical and physical properties of soil. The application of organic soil amendments influences the soil's physical improvement, especially the increase in soil macro pores. Prapagar *et al.* (2012) reported that the partially burned paddy husk had a remarkable effect in reducing soil salinity/sodicity. The decrease in EC might be due to leaching followed by the addition of organic amendments, which produced organic acids during decomposition, which was responsible for leaching of salts. Similar conclusions had also been reported by Singh *et al.* (2002). However, there was no significant influence of rate of sulphate of potash with amendment on electrical conductivity; it ranges from 4.00 to3.78 dS/m in the present study.

Plant Phosphorus content

The results showed to the application of PBPH and potassium (Table.1) show a significant influenced the phosphorus uptake in rice ($p<0.05$). Combining amendment with sulphate of potash significantly increased the phosphorus uptake in plants than non-amended soil. This may be due to the influence of potassium application and the favourable effects of partially burned paddy husk on the release and availability of phosphorus in soil solution. The PBPH application might have improved the nutrient retention in soil and increase the nutrient use efficiency. Among the different rates of application, 72 kg K_2O/ha showed highest P content (4.536 mg/g dry weight). This may be due to the high concentration of available phosphorus in soil solution by potassium application and the release of nutrients from organic amendment. Masulili *et al.* (2010) reported that the application of rice husk biochar increased available phosphorus content in soil thus increases the phosphorus uptake by plants.

The plants in soils with sulphate of potash and no PBPH indicated that the application of potassium increased the concentration of plant phosphorus content. The maximum content (3.721 mg/g dry weight) was observed in 72 kg

Table1: Effect of sulphate of potash and partially burnt paddy husk on soil EC, pH and Plant phosphorus content

Amendment application	Rate of Potassium (SOP)	Status of		
		Electrical conductivity (dSm^{-1})	Soil pH	Plant P level (mg/g DW)
Zero application	0 kg K_2O/ha	7.24±0.04[a]	7.90±0.06[a]	1.182±0.002[d]
	18 kg K_2O/ha	7.29±0.02[a]	7.88±0.01[a]	2.052±0.023[c]
	36 kg K_2O/ha	6.95±0.03[b]	7.84±0.01[a]	3.041±0.018[b]
	72 kg K_2O/ha	6.85±0.05[b]	7.82±0.01[a]	3.721±0.003[a]
PBPH (625 kg/ha)	0 kg K_2O/ha	4.00±0.02[a]	7.45±0.01[a]	2.871±0.003[d]
	18 kg K_2O/ha	3.90±0.09[a]	7.46±0.00[a]	3.207±0.003[c]
	36 kg K_2O/ha	3.83±0.06[a]	7.43±0.01[ab]	3.884±0.004[b]
	72 kg K_2O/ha	3.78±0.06[a]	7.40±0.01[b]	4.536±0.020[a]
P value	Amendment	0.0001	0.0001	0.0001
	SOP	0.0006	0.08	0.0001
	Interaction	0.0462	0.08	0.0001

The values are means of replicates ± standard error
Values in a column having different superscripts are significantly different according to the Duncan multiple range test at 5% significant level

K_2O/ha application and was followed by 36 kg K_2O/ha (3.041 mg/g dry weight) application. In both conditions, plant phosphorus concentration was increased significantly ($p<0.05$) with the increase in its rate from 0 to 72 kg K_2O/ha. It might be due to the impact of potassium on higher availability of phosphorus content in soil solution for the uptake by plants under saline condition. This may be attributed to low salt index of potassium sulphate in the root zone, which caused an in increasing in the uptake of phosphorus. This result was supported by Kausar and Gull, 2014 that potassium fertilization had a significant effect on the nutrient content nitrogen, phosphorus and potassium content in wheat.

Conclusion

Combining partially burned paddy husk with sulphate of potash decreased soil pH to near neutral and, decreased the soil electrical conductivity. Combining PBPH with sulphate of potash increased the phosphorus uptake in plants than non-amended soil. Highest plant phosphorus content was recorded in 72 kg K_2O/ ha application rate in both sulphate of potash amended and non-amended soil and the P contents 4.536 and 3.721 mg/g dry weight, respectively.

The results of this study suggested that by incorporating partially burned paddy husk with sulphate of potash, soil pH, electrical conductivity and phosphorus uptake by rice crop in saline soil might be improved.

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