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EFFECT OF ACIDITY AMELIORATION PRACTICES ON MICRONUTRIENT AVAILABILITY FOR RICE IN VAIKOM KARI SOILS OF KUTTANAD

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Abstract

A study was carried out in Vaikom Kari soils of Kuttanad, Kerala during the period from November 2014 to March 2015 to find out the availability of micronutrients viz. Fe, Mn, Zn, Cu and B as influenced by soil acidity amelioration practices for rice. The treatments included lime, dolomite and rice husk ash (RHA) applied as two splits one as basal and 30 DAS and the other as basal and one week before PI stage and a control without ameliorants. Lime treatments showed significantly lower values of available Fe. Higher soil available Mn was recorded by lime or dolomite treatments. Available Zn was not influenced by treatments at any of the stages. Soil available Cu status was the highest with control at PI stage and with dolomite as basal +PI at harvest stage. Lime, dolomite or RHA as basal + 30 DAS recorded higher B in the soil. The control plots recorded significantly lower status of available Mn and B and higher status of available Fe in the soil.

Keywords- kari soil, acid sulphate, rice, lime, dolomite, rice husk ash, micronutrients

I. INTRODUCTION

In Kerala, 94.7% of soils are acidic [2]. Acidity is a major problem in Kuttanad, which is the rice bowl of Kerala. . Soil of Kuttanad is distributed in and around Vembanad Lake in Alappuzha, Kottayam and Pathanamthitta districts. Kari soils are acid sulphate soils which are deep black in colour, heavy in texture, poorly aerated and ill drained and characterized by high organic matter content.

The soils are affected by severe acidity and periodic saline water inundation with consequent accumulation of soluble salts. All these problems result in a lower yield in these soils. According to [3] soil acidity causes nutrient stress to rice and is a main barrier to rice production. Liming enhances the physical, chemical and biological properties of acid soils [1]. Low soil pH and resultant problems like Fe toxicity and low availability of other nutrients are the most important soil related yield limiting factor in rice soils of Kerala. Imbalanced fertilizer application by farmers due to low response to added nutrients in acid soils of Kerala, not only increases the cost of crop production but also environmental safety of the farming system [4].

Lime shell (calcium carbonate - $CaCO_3$) is the most common liming material used in Kerala, however its reduced availability and high cost is restricting farmers from liming. Dolomite (calcium magnesium carbonate), which is comparatively a cheap liming material is also being imported from the neighbouring states. Rice husk ash (RHA) is a potential liming material which is an accumulating waste in rice mills and is cheap and environmental friendly. As it has an alkaline pH it can be used for amending soil acidity as well as improving available nutrient status [6]. This study aims at a comparison of using lime, dolomite and rice husk ash as soil acidity ameliorants in kari soils for enhancing soil micronutrient availability.

II. MATERIALS AND METHODS

The experiment was carried out in farmer's field in Vaikom Kari soils of very strongly acidic (pH 4.6 to 5.0) nature in Kallara village in Kottayam district with the objective of ameliorating soil acidity and improving nutrient availability. The experiment was laid out in RBD with seven treatments in three replications. The treatments were T_1-Lime in two splits as basal and at 30 DAS; T_2- Lime in two splits as basal and one week before 3rd dose of fertilizer application; T_3- Dolomite in two splits as basal and at 30 DAS; T_4- Dolomite in two splits as basal and one week before 3rd dose of fertilizer application; T_5- Rice husk ash in two splits as basal and at 30 DAS; T_6- Rice husk ash in two splits as basal and one week before 3nd dose of fertilizer application and T_7- Control where no liming material was applied. (Lime @ 600 kg ha^{-1}, applied in two splits of 350 and 250 kg ha^{-1}, dolomite @ 500 kg ha^{-1} as 300 and 200 kg ha^{-1} and rice husk ash @ 500 kg ha^{-1} as 300 and 200 kg ha^{-1} applied as per treatments). Fertilizers were uniformly applied to all plots as per KAU recommendations [5]. The variety used was high yielding medium duration variety Uma (MO-16), popular in the region and sprouted seeds were dibbled at a spacing of 20 cm X 10 cm, in plots of size 5 m x 2 m. The soil samples were taken initially before the crop, during four stages during the cropping period *viz.* seedling, tillering, panicle initiation (PI) and harvest stages.

III. RESULTS AND DISCUSSION

The soil was initially high in Fe which decreased in the ameliorated plots (Table 1). However, available Fe content increased at harvest stage than that at PI stage (Fig 1). The acidity amelioration practices had significant influence on soil available Fe content. The treatment T_7 (control) recorded significantly higher contents of soil available Fe at all stages. The control recorded significantly higher content of soil available Fe which was above the toxicity level at all stages which might be due to the low pH noticed in the control. All other treatments were on a par except lime treatments; Lime as basal + PI (T_2) at seedling stage and T_1 at tillering stage which showed significantly lower values. Significantly lower values were registered by T_2 at PI and harvest stages. Thus lime treatments were found superior for reducing the availability of Fe in the soil below the toxic level. The increased availability of Fe at harvest than other stages for all the treatments could also be due to the reduced soil pH or increased acidity owing to the diminishing effect of ameliorants towards the end of crop.

Similar to Fe, the soil available Mn content was also high initially (Table 1) which went below the initial value but was above the deficiency level, during the cropping period (Table 2). Significant effect of treatments on available Mn content in the soil was observed at all stages except at harvest. The highest soil available Mn was recorded by T_2 (lime as basal + PI) at seedling stage and was on a par with T_4 (dolomite as basal + PI) and T_1 (lime as basal + 30 DAS). At tillering, T_1 (lime as basal + 30 DAS) registered the highest value but was on a par with T_2, dolomite as basal + 30 DAS (T_3) and RHA as basal + PI (T_6). At PI stage, the highest soil available Mn was found with T_2 and was on a par with T_4 (dolomite as basal + PI). At all stages, T_7 (control) registered the lowest value of available Mn in the soil. Lime or dolomite application markedly increased available Mn in the soil. A decrease in the availability of Mn at harvest than that at PI stage as well as in control plots might have been due to the antagonistic effect of higher Fe content (Fig 1) resulted from lower soil pH. The occurrence of nutrient disorders and deficiencies of P, K, Ca, Mg, Mn and Zn due to Fe toxicity in plants was endorsed by [7], [8] and [9].

The available Zn status in soil was above the deficiency level initially (Table 1). Although Zn availability decreased from initial status during the cropping period irrespective of treatments, the status was maintained above the deficiency level (Table 2). No significant treatment effects on available Zn status were observed at any stage of sampling.

Initial status of soil available Cu was also high which decreased during the cropping period but was well above the deficiency level (Table 1). Acidity amelioration practices had significant influence on available Cu status at tillering and PI stages only. During and after the crop, available Cu content decreased from the initial status (Table 3). At tillering stage, T_7 (control) recorded the

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highest value and was on a par with dolomite treatments (T_4 and T_3). At PI stage, higher soil available Cu content was registered by T_4 (dolomite as basal + 30 DAS) which was on a par with T_7 and T_2 (lime as basal + PI). It is evident from the results that Cu availability which is usually higher at lower pH was not badly affected due to soil amelioration. This is evident from the higher Cu status much above the deficiency level in both the ameliorated and control plots. The control and dolomite as basal +PI recorded higher values respectively, at tillering and PI stages which means amelioration has no effect on soil Cu availability.

Initially the availability of B was deficient in the soil. Soil amelioration practices improved the availability of B but a decrease in B status was noticed at harvest which might be due to the crop removal and low soil pH. Initially the soil was deficient in B (Table 1) which improved during the cropping period (Table 3). Significant effect of treatments was observed on soil available B at all stages of sampling except at harvest. The highest soil available B was recorded by T_3 (dolomite as basal + 30 DAS) which was on a par with T_1 and T_6 at both seedling and tillering stages. At PI stage, T_4 (dolomite as basal + PI) showed the highest content of soil available B but was on a par with T_2. Lime or dolomite applied as basal and at PI increased the availability of B at PI stage. At all these stages, lower values were recorded by T_7 (control). Application of dolomite, lime or RHA as basal and at 30 DAS recorded higher B values which came above the level of sufficiency during the initial crop stages.

IV. CONCLUSION

It can be concluded that the availability of micronutrients are significantly influenced by acidity amelioration practices except in the case of Zn. Lime or dolomite application profoundly increased available Mn in the soil. Lime treatments were found superior for reducing the availability of Fe in the soil below the toxic level. The control and dolomite applied as basal +PI recorded better soil Cu availability. Application of dolomite, lime or RHA as basal and at 30 DAS recorded higher B values which came above the level of sufficiency during the initial crop stages. The effect of ameliorants was found to be diminished towards the harvest stage of the crop which necessitates the application of ameliorants repeatedly during every crop season.

Table 1. Initial status of soil in the experimental field

Soil parameters	Unit	Content	Rating
Available Fe	mg kg^{-1}	509.20	High
Available Mn	mg kg^{-1}	9.26	High
Available Zn	mg kg^{-1}	3.71	High
Available Cu	mg kg^{-1}	5.41	High
Available B	mg kg^{-1}	0.32	Low

Table 2. Effect of acidity amelioration practices on available Mn and Zn status in the soil, mg kg^{-1}

Treatments	Available Mn				Available Zn			
	Seedling	Tillering	PI	Harvest	Seedling	Tillering	PI	Harvest
T_1	5.61	7.09	5.69	4.59	1.90	2.13	2.16	2.82
T_2	8.26	6.36	7.62	4.36	2.94	2.29	1.97	3.01
T_3	4.75	6.16	5.23	4.16	3.37	2.48	2.37	3.61
T_4	6.16	5.27	6.69	4.68	2.12	1.63	1.57	2.19
T_5	4.70	5.33	5.79	3.78	2.44	1.93	2.22	2.41

T_6	3.87	5.83	5.17	4.46	3.22	2.84	2.66	3.49
T_7	2.67	3.27	2.83	2.92	3.57	2.22	1.84	2.25
SEm (±)	0.93	0.49	0.38	0.36	0.50	0.30	0.22	0.40
CD(0.05)	2.853	1.493	1.159	-	-	-	-	-

Table 3. Effect of acidity amelioration practices on available Cu and B status in the soil, mg kg^{-1}

Treatments	Available Cu				Available B			
	Seedling	Tillering	PI	Harvest	Seedling	Tillering	PI	Harvest
T_1	3.84	3.08	2.94	3.90	0.58	0.51	0.42	0.38
T_2	3.98	2.45	4.00	3.64	0.50	0.48	0.56	0.44
T_3	4.39	3.96	3.13	4.14	0.65	0.59	0.48	0.41
T_4	2.89	4.18	4.52	3.88	0.49	0.46	0.60	0.34
T_5	3.58	2.12	2.50	4.05	0.44	0.49	0.39	0.44
T_6	3.15	2.09	2.67	2.81	0.54	0.56	0.40	0.35
T_7	3.58	4.41	4.27	3.98	0.38	0.38	0.33	0.29
SEm (±)	0.36	0.24	0.43	0.51	0.04	0.03	0.03	0.04
CD(0.05)	-	0.751	1.328	-	0.121	0.093	0.089	-

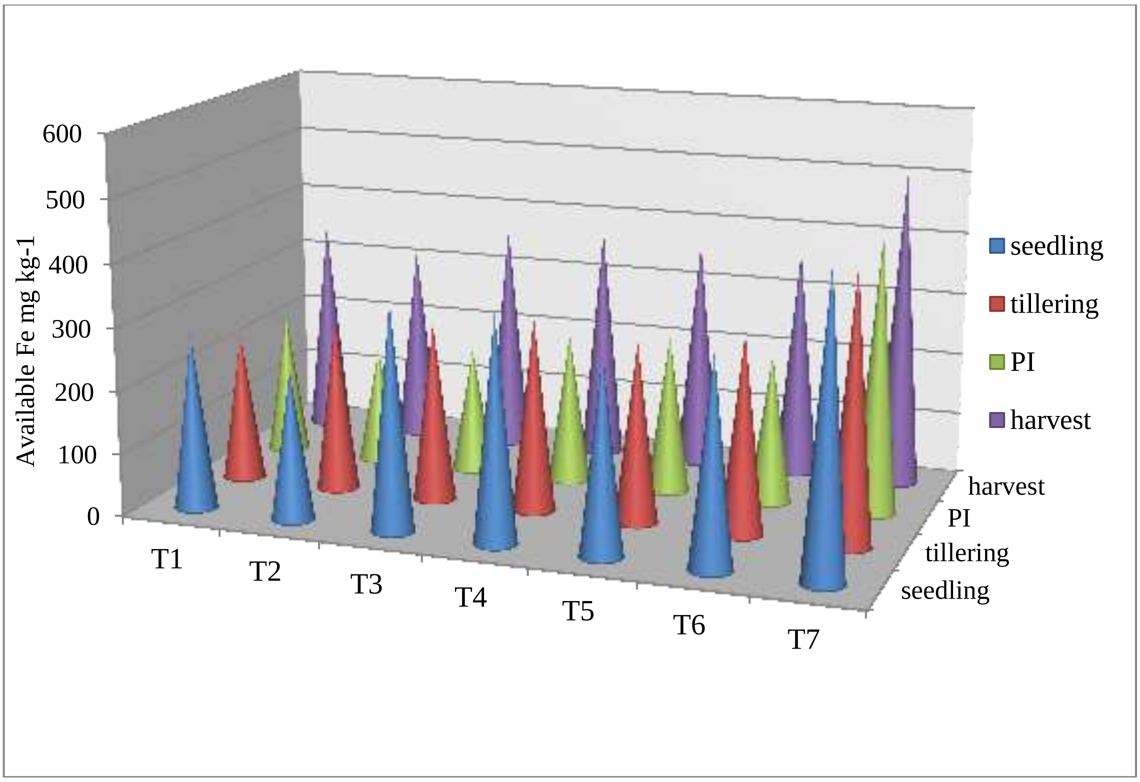

Figure 1. Effect of acidity amelioration practices on soil available Fe status, mg kg^{-1}

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