Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [1] 2017: 319-322

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

Influence of Integrated nutrient management practices on Concentration, uptake and recovery of the macro primary nutrients in maize crop in acid soil

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ABSTRACT
A pot experiment was conducted to assess "Influence of Integrated nutrient management practices on concentration, uptake and recovery of the macro primary nutrients in maize crop in acid soil" in The Dept. of Soil Science & Agricultural Chemistry, C.A. BBSR in Kharif. The pot experiment was conducted in an acid sandy loam soil with Maize as the test crop (Hybrid). In each pot filled with 5 kg of collected soil. Then 3 seeds were sown per pot. The experimental site experiences a warm and moist with hot and humid summer and mild winter. The observations are taken from these pot experiment was concentration, uptake and recovery of the macro primary nutrients in maize crop in acid soil. The mean minimum and maximum temperature were 22.1^{0}c and 31.9^0 c respectively. The treatments were given to Control (T_1), Soil test based recommended dose (STD) (T_2), Vermicompost (T_3), Lime (T_4), Lime + vermicompost (T_5), STD + VC@ 2.5 t ha^{-1} (T_6), STD + Lime (T_7), STD + VC @ 2.5 t ha^{-1}+ Lime (T_8). The results of the present experiment indicated that combined aplication of STD + VC @ 2.5 t ha^{-1}+ Lime was increase the concentration, uptake and recovery of the macro primary nutrients in maize crop in acid soil as compared to other treatments.
***Key words**: Pot culture, Lime, Macro primary nutrients, Acid soil, Vermicompost, Integrated nutrient management*

Received 10.07.2017 Revised 21.07.2017 Accepted 23.08. 2017

INTRODUCTION

The liming materials neutralised the activity due to H^+ and Al^{3+} and the exchange acidity to lower manageable level and raised the pH differently depending upon the neutralizing value of the sources. The liming material (calcium silicate) lower the exchange acidity and raises the pH. Calcium silicate addition proved to be efficient in increased the production of dry matter of plants, N accumulation in the aerial part of the plant. The results of the present study show that the combination of VC, NPK and calcium silicate might represent a key factor in the recovery of soil nutrients. Soil acidity and elemental toxicities or deficiencies associated with it, affects crops growth and restricts yields throughout the world (Eswaran et al., 1997; Rengel et al., 2003). Acid soil with a pH lower than 5.50 are widespread in Croatia and cover a large area of arable land (Kovacevic et al., 1993; Loncaric et al., 2005). Amelioration of acid soil by different liming materials can raise soil pH, benefiting soil properties and plant growth and liming is widely practiced for improving the acid soils productivity. Soil acidity is a major yield limiting factor for crop production worldwide. Land area affected by acidity is estimated at 4 billion hectares, representing approximately 30% of the total ice-free land area of the world (Sumner and Noble, 2003). In the tropics, substantial weathering of soils over millennia has resulted in the leaching of crop nutrient bases (mainly K, Mg and Ca) followed by their replacement by H, Al, Mn cations which have contributed to acid related stresses on crop production (Okalebo et al., 2009).

In India, the acid soils occupy 90 million ha covering 25 per cent of the total geographical area (Sarkar and Sharma, 2005).About 80 per-cent of Odisha soils are acidic. Low water holding capacity, high bulk density, and soil crusting along with chemical constraints like low pH, low CEC, low base saturation (16 to67 per-cent), high Al, Fe and Mn saturation, and high P fixing capacity (80 to 91per-cent) are major reasons for low crop productivity in such soils (Misra et al., 1989). Acid soils are generally deficient in Ca, Mg, P, Mo, B, and Si. The availability of Fe, Mn, Cu and Zn is high, sometimes reaching toxic levels. These problems can be managed by inorganic and organic ameliorants. Lime application (inorganic) elevates pH, base saturation, and cation exchange capacity and reduces Al, Fe, and Mn availability, acidity andP fixation (Misra *et al*., 1989; Mishra and Pattanayak, 2002; Sethi, 2015). Organic ameliorants (FYM/compost) reduce exchangeable Al in soil through precipitation with hydroxyl ions (Sethi, 2015). Combined use of organic and inorganic ameliorants simultaneously controls soil acidity, reduces Aland Fe toxicity, and increases nutrient availability (Misra and Das, 2000) leading to better crop growing conditions in these soils. So a pot culture and an incubation study will conduct by using industrial by product and organic residues, which are potential lime sources.

MATERIALS AND METHODS

Soil was collected from Central Horticultural Research Station, OUAT. Then the samples were processed by removing grasses, stones and other waste materials. In each pots 5 kg of collected soil were filled up. Before sowing calculated amount of calcium silicate, fertilizers and VC mixed properly in experimental soil. Then 3 seeds were sown per pot. The treatments were given to Control (T_1), Soil test based recommended dose (STD) (T_2), Vermicompost (T_3), Lime (T_4), Lime + vermicompost (T_5), STD + VC@ 2.5 t ha^{-1} (T_6), STD + Lime (T_7), STD + VC @ 2.5 t ha^{-1}+ Lime (T_8).

Collection and Processing of Plant samples

At the time of harvesting stage all three plants from each treatment were selected randomly . The roots from different treatments were collected at the time of harvest of the crop by moisturing the rhizosphere, uprooting the plants without disturbing the roots with the help of spade. The entire root and adhered soils were loosen in a bucket of water, saving the roots. Then washed thoroughly and dried. The plant parts like stem and roots were kept in separate envelops, washed, labeled properly and dried in hot air oven till a constant weight was recorded. Each sample was grinded separately and was used for analysis of different elements.

The stem and root samples were analysed for determination of N,P,K concentration. Nitrogen in the processed sample was determined by Kjeldahl digestion method as described in AOAC (1960). The samples were digested in diacid mixure [HNO_3 : $HClO_4$ (3:2)]. The P was estimated spectrophotometrically, Kb flame photometer. (Jackson,1973)

(b) Nutrient uptake (kg ha^{-1}) = Dry matter (q/ha) x nutrient concentration (%)

(c) Apparent Recovery of Nutrient (%) =

$$\frac{\text{Uptake of nutrient in desired treatment – Uptake in absolute control}}{\text{Amount of nutrient added}} \times 100$$

RESULTS & DISCUSSION

In order to study the **"Influence of Integrated nutrient management practices on concentration, uptake and recovery of the macro primary nutrients in maize crop in acid soil".** The pot experiment was conducted in an acid sandy loam soil with Maize as the test crop (Hybrid). The experiment was conducted by applying inorganic and organic fertilizer and the soil was ameliorated with a liming materials (Calcium-silicate @ 0.2LR) added with soil test based dose with or without Vermicompost (VC)@ 2.5 t/ha.

Concentration, uptake and recovery of the nutrients as influenced by INM practices

Nitrogen :

The concentration N in different maize plant parts and uptake through these parts have been presented in Table-1.

Table-1- Concentration, uptake and recovery of the Nitrogen as influenced by INM practices

	Treatments	Concentration (%)		Uptake (mg/pot)			Apparent N recovery (%)
		Shoot	Root	Shoot	Root	Total	
T1	Absolute control	1.1	0.8	85.1	37.72	122.82	
T2	Soil test based recommended dose (STD)	1.2	1.01	150.16	57	207.16	120.49
T3	Vermiculite @ 2.5 t ha^{-1}	1.31	1.06	167.9	66.4	234.3	136.00
T4	Ca-Silicate @ 0 .2 LR	1.34	1.09	198.7	74.6	273.3	150.48
T5	@ 2.5t ha^{-1} + Ca-Silicate @ 0 .2	1.39	1.13	255.4	83.5	338.9	198.67

	LR						
T6	STD + VC @ 2.5 t ha^{-1}	1.33	1.08	237	76.1	313.1	260.66
T7	STD + Lime	1.12	1.12	276.5	84	360.5	339.54
T8	STD + VC @ 2.5 t ha^{-1} + Ca-Silicate @ 0 .2 LR	1.4	1.18	306.4	96.3	402.7	383.40

The concentration of N in maize stover was more (from 1.1 to 1.4%) than its root (from 0.8 to 1.18 %). The higher concentration of N observed in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR in shoot (1.4%) and root(1.18%) and lower concentration of N observed in absolute control. The uptake of N was observed higher in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR in shoot 306.4 mg/pot and root 96.3 mg/pot and The uptake of N was lower observed in absolute control. The total uptake was higher in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR as compared to other treatment.

The appearent recovery N % was observed higher in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR in was 383.40% and lower in absolute control.

Phosphorus :

The data relating to the concentration of P and its uptake through maize crop have been presented in Table -2.

The concentration of P in maize stover was more (from 0.040 to 0.161%) than its root (from 0.013 to 0.052 %). The higher concentration of P observed in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR in shoot (0.161%) and root (0.052 %) and lower concentration of P observed in absolute control.

The uptake of P was observed higher in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR in shoot 35.24 mg/pot and root 4.244 mg/pot and The uptake of P was lower observed in absolute control. The total uptake was higher in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR as compared to other treatment.

The appearent recovery P % was observed higher in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR in was 49.68% and lower in absolute control.

Table-2- Concentration, uptake and recovery of the Phosphorus as influenced by INM practices

	Treatments	Concentration (%)		Uptake (mg/pot)			Apparent P recovery (%)
		Shoot	Root	Shoot	Root	Total	
T1	Absolute control	0.040	0.013	3.09	0.613	3.71	
T2	il test based recommended dose (STD)	0.098	0.021	12.26	1.185	13.45	13.91
T3	Vermiculite @ 2.5 t ha^{-1}	0.118	0.027	15.12	1.691	16.82	17.81
T4	Ca-Silicate @ 0 .2 LR	0.134	0.034	19.87	2.327	22.20	18.49
T5	VC @ 2.5t ha^{-1} + Ca-Silicate @ 0 .2 LR	0.141	0.043	25.91	3.177	29.08	40.97
T6	STD + VC @ 2.5 t ha^{-1}	0.133	0.038	23.70	2.678	26.38	31.48
T7	STD + Lime	0.144	0.047	29.28	3.525	32.80	41.56
T8	STD + VC @ 2.5 t ha^{-1} + Ca-Silicate @ 0 .2 LR	0.161	0.052	35.24	4.244	39.48	49.68

Potassium :

The data related to potassium concentration and uptake by Maize crop have been presented in Table- 3.

The concentration of K in maize stover was more (from 0.72 to 1.51%) than its root (from 0.13 to 0.56 %). The higher concentration of K observed in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR in shoot (1.51%) and root (0.56%) and lower concentration of K observed in absolute control. The uptake of K was observed higher in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR in shoot 330.47 mg/pot and root 45.70 mg/pot and The uptake of K was lower observed in absolute control. The total uptake was higher in STD + VC @ 2.5 t ha^{-1}+ Ca-Silicate @ 0 .2 LR as compared to other treatment.

The appearent recovery K % was observed higher in STD + VC @ 2.5 t ha^{-1} + Ca-Silicate @ 0 .2 LR in was 443.64% and lower in absolute control.

Table-3- Concentration, uptake and recovery of the Potassium as influenced by INM practices

	Treatments	Conc (%)		Uptake (mg/pot)			Apparent K recovery (%)
		Shoot	Root	Shoot	Root	Total	
T1	Absolute control	0.72	0.13	55.70	6.13	61.83	
T2	Soil test based recommended dose (STD)	1.10	0.28	137.65	15.80	153.45	152.70
T3	Vermiculite @ 2.5 t ha^{-1}	1.16	0.35	148.67	21.92	170.60	140.64
T4	Ca-Silicate @ 0 .2 LR	1.19	0.39	176.46	26.69	203.15	141.32
T5	VC @ 2.5t ha^{-1} + Ca-Silicate @ 0 .2 LR	1.31	0.43	240.70	31.77	272.48	311.50
T6	STD + VC @ 2.5 t ha^{-1}	1.29	0.38	229.87	26.78	256.65	324.70
T7	STD + Lime	1.44	0.47	292.76	35.25	328.01	443.64
T8	STD + VC @ 2.5 t ha^{-1} + Ca-Silicate @ 0 .2 LR	1.51	0.56	330.47	45.70	376.18	498.96

Crop production under optimum growing environment (through crop growth) utilizes the inputs/resources efficiently. Where constraints remains, the inputs are inefficiently utilized which are reflected in production. In the present study soil ameliorants both inorganic (lime) and organic (VC) influenced the growth of maize crop for uptake of N,P,K.

Recovery efficiency for P was most influenced by amelioration practice from 13.91 to 49.68 per cent, for K from 152.70 to 498.96 per cent. As maize is one exhaustive crop for soil, inspite of fertilizer, lime and VC addition, due to removal of nutrients (mostly basic) the soil had turned acidic, due to frequent intercultural operations facilitating carbon oxidation process had resulted in depletion of organic carbon status. Post harvest available N status decreased in control where it was not added. Its status either maintained or increased in rest of the treatments compared to initial, but these were under low status of ratting.

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CITATION OF THIS ARTICLE

Tupaki Lokya, Antaryami Mishra, Sugyata Shivhare, J. Ravinder , Suraj Mali and Kiran Pilli. Influence of Integrated nutrient management practices on Concentration, uptake and recovery of the macro primary nutrients in maize crop in acid soil.Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue 1, 2017: 319-322