

Influence of Integrated Nutrient Management Practices on Biomass Yield and Growth of Maize Crop in Acid Soil

Tupaki Lokya^{1*}, Antaryami Mishra¹, J. Ravinder², Sugyata Shivhare¹ and Suraj Mali¹

¹Department of Soil Science and Agricultural Chemistry, College of Agriculture, OUAT, Bhubaneswar-751003, Odisha, India

²Department of Soil Science and Agriculture Chemistry, UBKV, Pundibari, Cooch Behar-736165, West Bengal, India

*Corresponding author

ABSTRACT

Keywords

Pot culture, Lime, Acid soil, Vermicompost, Integrated nutrient management.

Article Info

Accepted:
19 July 2017
Available Online:
10 September 2017

A pot experiment was conducted to assess "Influence of Integrated nutrient management practices on biomass yield and growth of maize crop in acid soil" in The Dept. of Soil Science and 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 mean minimum and maximum temperature were 22.1⁰c and 31.9⁰ c respectively. The treatments were given to Control (T₁), Soil test based recommended dose (STD) (T₂), Vermicompost (T₃), Lime (T₄), Lime + vermicompost (T₅), STD + VC@ 2.5 t ha⁻¹ (T₆), STD + Lime (T₇), STD + VC @ 2.5 t ha⁻¹+ Lime (T₈). The results of the present experiment indicated that combined application of STD + VC @ 2.5 t ha⁻¹+ Lime was increase the biomass yield and growth of maize crop in acid soil as compared to other treatments.

Introduction

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). Acid

infertility factors limit crop growth and yield as well as soil productivity in highly weathered soils of humid and sub-humid regions of the world due to deficiency of essential nutrient elements

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 to 67 per-cent), high Al, Fe and Mn saturation, and high P fixing capacity (80 to 91 per-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 and P 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). The organic acids released from organic ameliorants complex with Al and Fe, reducing their availability and harmful effects. Combined use of organic and inorganic ameliorants simultaneously controls soil acidity, reduces Al and 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. Hence, the purpose of the present investigation is to evaluate the “Influence of Integrated nutrient management practices on biomass yield and growth of maize crop in acid soil”.

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 (T₁), Soil test based recommended dose (STD) (T₂), Vermicompost (T₃), Lime (T₄), Lime + vermicompost (T₅), STD + VC @ 2.5 t ha⁻¹ (T₆), STD + Lime (T₇), STD + VC @ 2.5 t ha⁻¹ + Lime (T₈).

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 mass (weight) and volume was estimated by water displacement method and the density was calculated. The plant parts like stem and roots were kept in separate envelopes, 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. photosynthetic activity was measured by SPAD chlorophyll meter.

$$\left. \begin{aligned} \text{Relative Agronomic Efficiency (RAE)} = & \\ \frac{\text{Total Biomass production in treatment} -}{\text{Total Biomass production in Absolute Control}} & \\ \text{-----} & \\ \frac{\text{Total Biomass production in STD} -}{\text{Total Biomass production in Absolute Control}} & \\ & \text{-----} 100 \end{aligned} \right\}$$

Results and Discussion

In order to study the “”Influence of Integrated nutrient management practices on biomass yield and growth of 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.

Influence of INM practice on growth parameters during crop growth period

Chlorophyll content

The photosynthetic activity (chlorophyll content) of maize crop under the influence of INM practices had been presented in table 1.

The photosynthetic activity was measured by SPAD chlorophyll meter. The values recorded at five growth stages starting from 15th DAS till 75th DAS. Rate of increasing of SPAD value was higher in treatment T₈ as compared to other treatment at 15th DAS and 75th DAS SPAD value was 50 and 77.2 respectively. The rate of increasing is significantly high in limed treatments in comparison to unlimed treatments.

The treatment composed up by only STD, vermicompost and inorganic fertilizer SPAD value was low in comparison to limed treatments. Highest SPAD value (77.2) was observed in 75th DAS of T₈.

Plant height (cm) and growth rate (cm/day)

The maize crop heights recorded at different growth stages have been presented in table 2. The height of the crop continued to grow at differential rates under different treatments. Rate of increasing of plant height was higher

in treatment T₈ as compared to other treatment at 15th DAS and 75th DAS was 27 cm and 71.3 respectively. The rate of increasing plant height is significantly high in limed treatments in comparison to unlimed treatments. The treatment composed up by only STD, vermicompost and inorganic fertilizer plant height was low in comparison to limed treatments. Highest plant height (71.3) was observed in 75th DAS of T₈.

The growth rate of the crop differed from treatment to treatment and from day to day. Growth rate of the crop was 1.02 cm day⁻¹ at 15th DAS in absolute control treatment which increased to 1.22 cm day⁻¹ with STD, still higher with liming materials when used either alone or more with VC, STD + Lime and STD + VC @ 2.5 t ha⁻¹ + Ca-Silicate @ 0.2 LR ranging 1.34 cm day⁻¹, 1.53 cm day⁻¹, 1.59 cm day⁻¹ and 1.73 cm day⁻¹ (Table 3) respectively at 15th DAS.

The growth rate increased irrespective of the treatments up to 75th DAS except in control. All along the growing period integrated use of inputs had recorded positive influences.

Influence of INM practice on root characteristics

At harvest, the root weight, volume, and calculated density have been presented in table 4.

Root volume

The volume of roots under absolute control treatments ranged was 25 cc is lowest and highest volume of roots was observed in STD + CS @ 0.2 LR + VC was 58 cc. There was significant influence of application of liming materials and their combined use with VC, STD and CS on root volume. Highest root volume was observed in treatment T₈ (Table 4).

Table.1 Influence of INM practice on chlorophyll content

Treatments		Days After Sowing				
		15	30	45	60	75
T1	Absolute control	28.5	29	33	37.4	40.7
T2	Soil test based recommended dose (STD)	44.5	53.2	55	63.2	65.5
T3	Vermiculite @ 2.5 t ha ⁻¹	46.2	48.7	57.5	64	66.3
T4	Ca-Silicate @ 0.2 LR	46.8	50	57.9	64.7	67.4
T5	VC @ 2.5t ha ⁻¹ + Ca-Silicate @ 0.2 LR	48	51.5	59.3	66.8	70
T6	STD + VC @ 2.5 t ha ⁻¹	47	50.3	58	65.7	69.6
T7	STD + Lime	48.2	52	60.1	67	71.5
T8	STD + VC @ 2.5 t ha ⁻¹ + Ca-Silicate @ 0.2 LR	50	56.5	64.3	71	77.2

Table.2 Influence of INM treatment on plant height (cm)

Treatments		Days After Sowing				
		15	30	45	60	75
T1	Absolute control	15.7	26	29.1	32.4	34.7
T2	Soil test based recommended dose (STD)	18.2	33.5	38	43.2	47
T3	Vermiculite @ 2.5 t ha ⁻¹	20.1	35	39.5	44.8	49.8
T4	Ca-Silicate @ 0.2 LR	21.2	35.9	40.3	46.3	55
T5	VC @ 2.5t ha ⁻¹ + Ca-Silicate @ 0.2 LR	23	37.3	43.6	47	58.5
T6	STD + VC @ 2.5 t ha ⁻¹	22.4	36.7	42	46.3	57
T7	STD + Lime	23.5	38	44.9	52.6	63.8
T8	STD + VC @ 2.5 t ha ⁻¹ + Ca-Silicate @ 0.2 LR	27	42	51.7	59.5	71.3

Table.3 Influence of INM treatment on plant growth rate (cm/day)

Treatments		Days After Sowing				
		15	30	45	60	75
T1	Absolute control	1.02	1.16	0.96	0.81	0.71
T2	Soil test based recommended dose (STD)	1.22	1.46	1.28	1.07	1.01
T3	Vermiculite @ 2.5 t ha ⁻¹	1.31	1.49	1.34	1.11	1.04
T4	Ca-Silicate @ 0.2 LR	1.34	1.52	1.36	1.17	1.08
T5	VC @ 2.5t ha ⁻¹ + Ca-Silicate @ 0.2 LR	1.53	1.61	1.44	1.36	1.24
T6	STD + VC @ 2.5 t ha ⁻¹	1.42	1.5	1.41	1.33	1.18
T7	STD + Lime	1.59	1.68	1.51	1.44	1.35
T8	STD + VC @ 2.5 t ha ⁻¹ + Ca-Silicate @ 0.2 LR	1.73	1.81	1.71	1.6	1.52

Table.4 Influence of INM practice on root characteristics

	Treatments	Root volume (cm ³)	Root density (g/cm ³)
T1	Absolute control	25	0.18
T2	Soil test based recommended dose (STD)	34.1	0.16
T3	Vermiculite @ 2.5 t ha ⁻¹	37.4	0.17
3z	Ca-Silicate @ 0.2 LR	38	0.17
T5	VC @ 2.5t ha ⁻¹ + Ca-Silicate @ 0.2 LR	43	0.18
T6	STD + VC @ 2.5 t ha ⁻¹	46.8	0.17
T7	STD + Lime	51.1	0.18
T8	STD + VC @ 2.5 t ha ⁻¹ + Ca-Silicate @ 0.2 LR	58	0.19

Table.5 Biomass yield (g pot⁻¹) and relative agronomic efficiency (%)

	Treatments	Root	Shoot	R:S	Total biomass (g pot ⁻¹)	Relative Agronomic Efficiency (%)
T1	Absolute control	4.6	8.1	0.57	12.7	
T2	Soil test based recommended dose (STD)	5.7	12.93	0.44	18.63	100
T3	Vermiculite @ 2.5 t ha ⁻¹	6.1	13.5	0.45	19.6	116.4
T4	Ca-Silicate @ 0.2 LR	6.6	14.9	0.44	21.5	148.4
T5	VC @ 2.5t ha ⁻¹ + Ca-Silicate @ 0.2 LR	7.3	16.5	0.44	23.8	187.2
T6	STD + VC @ 2.5 t ha ⁻¹	6.4	15.6	0.41	22	156.8
T7	STD + Lime	8.4	18.7	0.45	27.1	242.8
T8	STD + VC @ 2.5 t ha ⁻¹ + Ca-Silicate @ 0.2 LR	10.33	25.2	0.41	35.53	385.0

Root density

As a result of variation in root weight (mass) and volume of maize crop due to the application of liming materials either alone or with FYM, their density varied between 0.16 and 0.19 g/cc.

Biomass yield (g pot⁻¹) and relative agronomic efficiency (%)

The total biomass production of maize crop significantly Varied between 12.7 and 35.53 g

pot⁻¹ under the influence of lime, VC and fertilizers applications. The total biomass production of maize crop observed lower in T₁ and higher in T₈ (STD + VC @ 2.5 t ha⁻¹+ Ca-Silicate @ 0.2 LR). Individual input had significant influence on biomass production (Table 5).

Considering the efficiency of CS in biomass production taken as 100, the performance of other integrated treatments varied between 116.4 % and 385 %. The performance of different treatments can be arranged as

follows: T1<T2<T4<T3<T5<T6<T7<T8. The result showed highest RAE (%) in the treatment T₈.

The “Influence of Integrated nutrient management practices on biomass yield and growth of maize crop in acid soil” was studied with the help of pot experiment in the Department of Soil Science & Agricultural chemistry, C.A, OUAT, BBSR. The liming materials used in experiment was an industrially processed source calcium silicate (CS). The CS was applied @ 0.2 LR for monocot crop maize.

The beneficial function of fertilizers application, its integration with lime sources and further combination with VC was not only reflected on growth on above ground portion but also on underground portion i.e., root. The increase in root mass and density due to integrated use of lime sources with STD.

Root weight, their volume and density were influenced by soil amelioration measure with lime sources and more positively by combined use of VC. Similar results of positive impact of liming on root grown were also reported by Pattanayak and Mishra, 2002.

The proper inorganic nutrition of crop coupled with acid soil amelioration measures with lime sources and further with organic source FYM, not only produced bigger sized cobs which could accommodate more grains compared to no fertilization and no amelioration measure was indicative of better growing environment for higher production with INM practice. The results corroborate the findings of Pattanayak and Mishra, 2002.

The positive influence of proper crop nutrition, soil amelioration with inorganic (lime) and organic (FYM) ameliorants not

only restricted to the growth of the maize plant, root but also the biomass production of maize. Under the system of integrated nutrient management, constraints for production were taken care to provide optimum growing environment for maize crop to produce as per the treatment specificity. Combined application of organic ameliorant (VC) with lime sources influenced biomass production. These results indicate that combined use of inorganic and organic ameliorants is essential for better yield. But the test was conducted under close system (Pot experiment). These results are in agreement with the results reported by Mishra and Pattanayak (2002), Mishra, 2004, Sharma and Sarkar (2005).

References

- AOAC, 1960. Official Methods of Analysis of the Association of Official Agricultural Chemists, pp 12-13.
- Eswaran, H., Reich, P., Beinroth, F. 1997. Global distribution of soils with acidity. In: Moniz A.C., Furlani A.M.C., Schaffert R. E., Fageria N.K., Rosolem C.A. and Cantarella H. (eds.). Plant-Soil Interactions at Low pH. Campinas, Brazil, Brazilian Society of Soil Science. Pp. 159–164.
- Jackson, M.L., 1973. Soil Chemical Analysis (Edn. 2) Prentice Hall of India Pvt. Ltd., New Delhi. pp. 69-182.
- Kovacevic, V., Bertic, B., Grgic, D. 1993. Response of maize, barley, wheat and soybean to liming on acid soils. *Rostlinna Vyroba* 39(1): 41-52.
- Loncaric, Z., Karalic, K., Vukadinovic, V., Bertic, B., Kovacevic, V. 2005. Variation of liming recommendation caused by calculation approach. In: C.J. Li *et al.*, (eds.), Plant nutrition for food security, human health and environmental protection. Tsinghua University Press. Beijing, China. Pp. 1042-1043.

- Mishra, M., and Pattanayak, S.K. 2002. Response of crops to graded doses of lime amended with or without FYM in different crops grown in acid soil. Professor IFFCO chair report, OUAT, Bhubaneswar.
- Misra, U. K., Satpathy, S. and Panda, N. 1989. Characterization of some acid soils of Orissa 1- Nature of soil acidity. *J. Indian Soc. Soil Sci.* 37: 22-28.
- Misra, U.K., and Das, N 2002. Phosphorous availability to maize as influenced by organic amendments. *J. Indian Soc. Soil Sci.* 48: 298-305.
- Okalebo, J.R., Othieno, C.O., Nekesa, A.O., Ndungu-Magiroi, K.W., Kifuko Koech, M.N., 2009. Potential for agricultural lime on improved soil health and agricultural production in Kenya. *Afr. Crop Sci. Conf. Proc.* 9: 339-341.
- Rengel, Z., (ed.): 2003. Handbook of Soil Acidity. Marcel Dekker, Inc. New York, Basel.
- Sarkar, A.K., and Sharma, P.D. 2005. Managing Acid Soils for Enhancing Productivity. National Resource Management Division (ICAR), New Delhi. pp.23.
- Sethi, D., 2015. P. G. Thesis submitted to Dept. Soil Sc. and Agril. Chem, OUAT. Effect of LD slag as soil ameliorant and its impact on native PSB population in acid *Alfisols* of Bhubaneswar.
- Sumner, M.E., Noble, A.D. 2003. Soil acidification: The world story. In: Rengel. Z, (Eds.). Handbook of Soil Acidity, Marcel Dekker, New York. pp. 1-28.

How to cite this article:

Tupaki Lokya, Antaryami Mishra, J. Ravinder, Sugyata Shivhare and Suraj Mali. 2017. Influence of Integrated Nutrient Management Practices on Biomass Yield and Growth of Maize Crop in Acid Soil. *Int.J.Curr.Microbiol.App.Sci.* 6(9): 1429-1435.
doi: <https://doi.org/10.20546/ijemas.2017.609.173>