



## **Acid Soil Management in Jhum Fields of Maize under Zunheboto District of Nagaland**

**Sentimenla<sup>1\*</sup>**

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### **Author's contribution**

*The sole author designed, analysed, interpreted and prepared the manuscript.*

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### **ABSTRACT**

Maize (*Zea mays* L.) is an important cereal crop in the world due to its adaptability towards varied agro-climatic conditions. It is considered the Queen of the cereals. It ranks third among the cereals next to wheat and rice. The leading producer of maize is USA with 10.34 t ha<sup>-1</sup> followed by Argentina (5.61 t ha<sup>-1</sup>) and China (5.35 t ha<sup>-1</sup>). It is the third most important cereal next to rice and wheat contributing about 10% of the total food grain production. Maize is the second most important crop next to rice in the Northeast region of India grown under rainfed upland soils. It is used for direct consumption as well as feeds to the farm animals. The area under maize in Zunheboto district of Nagaland is 10,100 hectare, however its productivity is only about 1.98 Mt ha<sup>-1</sup> and hence its production needs to be improved. The soils are acidic in this region and often needs to be reclaimed to increase the productivity of the maize. A field level demonstrations on acid soil management using lime was conducted based on the soil type and pH in upland jhum fields of Aotsakili and Sumi Settsu villages under Zunheboto district of Nagaland covering 2 hectares. It was observed that with the application of lime, the average mean of pH was increased from 6.2 to 6.4 and the mean yield of maize was 2300 kg ha<sup>-1</sup> over control (1600 kg ha<sup>-1</sup>) with B:C ratio of 2.6 over farmers practice 2.2. This technology was found to be beneficial and suitable for neutralizing soil acidity for crop production.

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**Keywords:** Soil acidic; jhum; lime; maize.

## 1. INTRODUCTION

In india, maize is the third most important cereal crop next to rice and wheat and accounts for about 10% of the total food grain production. The major maize growing states in india are karnataka (15%), rajasthan (13%) and madhya pradesh (10%). The estimated production of maize was 21,810 thousand tons in 2015-16 and the quantity of maize exported was 3,70,066.11 metric tons in 2019-20 [1,2].

The soils of this region are acidic in nature due to factors such as receiving heavy precipitation which ultimately aids in weathering of acidic parent materials and the undulated topography and relief leading to soil acidity. The soils of Northeast region of India is acidic where 97% of the area in Nagaland is acidic in reaction [3]. This may be due to acidic parent materials, heavy rainfall and vegetation covers (Ritcher, 1986). Soil acidity is a serious problem which is being considered an important agricultural concern in crop growth and production in Nagaland [4]. Liming is an important soil ameliorant to enhance crop yield in acidic soil [5]. Chemlila et al. [6] also reported that requirement of lime had a significant negative correlation with pH, positive correlation with organic carbon and varying range of soil acidity. It neutralises the soil acidity through dissolving and releasing bases into the soil solution which reacts with the acidic components such as hydrogen and aluminum [7]. Liming mobilizes nutrient ions and immobilizes heavy metals for sustainable agricultural production and protection of soil environment [8]. It also helps to reduce fixation of phosphate by iron and aluminium and enable plants to take up the nutrient [9]. Liming plays an important role in neutralizing the soil pH, increases the nutrient availability to the crop, improves the soil structure and enhance plant growth [10]. So acidic soils need to be reclaimed for neutralizing the soil acidity and enhance better nutrient absorption by the plants thereby increasing the productivity of the maize. Therefore a field level demonstrations on acid soil management using lime was conducted in the upland jhum fields of two villages such as Aotsakili and Sumi Settsu under Zunheboto district of Nagaland. The fields under trials covered 2 hectares of land under rainfed condition. Jhum which is also known as shifting cultivation is a traditional farming practice of the hill people where land is cleared for cultivation by felling the trees, slashing and burning the jungle before sowing.

This farming practice is carried out by majority of the farming community. The soil type of these location were red sandy loam and falls under the soil order ultisols. The areas have low in available nitrogen, low available phosphorus and low available potassium. Micronutrients such as zinc and boron were also found to be deficient in these areas. The areas were moderately steep slopes (10 – 15)% with low to medium organic carbon with pH ranging from 6.1 to 6.3.

## 2. MATERIALS AND METHODS

A field level demonstration was carried out in two villages under Zunheboto district of Nagaland viz., Aotsakili and Sumi Settsu covering 2 ha of jhum lands. A total of 6 demonstrations in each village were carried out during 2018-19.

This technology used 350 kg/ha of lime in jhum fields. The fields were slightly acidic ranging from 6.1-6.3, low to medium organic C ranging from 0.29-0.52%, 230-245 kg ha<sup>-1</sup> of low available N, 9.18-14.07 kg ha<sup>-1</sup> of low available P (P<sub>2</sub>O<sub>5</sub>) and 109.81-100.23 kg ha<sup>-1</sup> of low available K (K<sub>2</sub>O).

The maize crop was sown during the kharif season on 10th of june 2018 using maize HQPM-1 variety and harvested on 26th of oct 2018. Parameters such as yield, gross income, cost of cultivation, net return and B:C ratio were recorded and compared between the farmers traditional and recommended practice.

The Soil fertility status of the fields were analysed before and after harvest. The soil pH, organic carbon, available nitrogen, available phosphorus and available potassium were also analysed using pH meter (Jackson, 1973), Walkely and Black method (Jackson, 1973), alkaline KMnO<sub>4</sub> distillation method (Subbiah and Asija, 1956), Bray's No. 1 method (Bray and Kurtz, 1945), flame photometer (Jackson, 1973).

## 3. RESULTS AND DISCUSSION

The results were compared between the demonstrated jhum field and the traditional farmer's practice where liming is not used in the acidic soil. Application of 350 kg of lime ha<sup>-1</sup> in red sandy loam textured soils showed higher yield as compared to the traditional farmer's practice. The mean yield from the demonstrated plots were 2300 kg ha<sup>-1</sup> as compared to the farmer's practice (1600 kg ha<sup>-1</sup>). This shows that

**Table 1. Effect of lime on yield and economics of maize**

| Name of the village | No. of demonstrations | Yield (kg ha <sup>-1</sup> ) |      | Cost of cultivation (Rs) |         | Gross income (Rs) |       | Net return (Rs) |          | B:C ratio (Rs) |     |
|---------------------|-----------------------|------------------------------|------|--------------------------|---------|-------------------|-------|-----------------|----------|----------------|-----|
|                     |                       | FP                           | DP   | FP                       | DP      | FP                | DP    | FP              | DP       | FP             | DP  |
| Aotsakili           | 6                     | 1700                         | 2400 | 5913.04                  | 7111.11 | 13600             | 19200 | 7686.96         | 12088.89 | 2.3            | 2.7 |
| Sumi Settsu         | 6                     | 1500                         | 2200 | 5714.28                  | 7040    | 12000             | 17600 | 6285.72         | 10560    | 2.1            | 2.5 |
| Mean                | 6                     | 1600                         | 2300 | 5813.66                  | 7075.56 | 12800             | 18400 | 6986.34         | 11324.45 | 2.2            | 2.6 |

FP= Farmers Practice, DP= Demonstrated Plot

**Table 2. Effect of lime on soil fertility**

| Name of the village | Soil fertility status ( Kg ha <sup>-1</sup> ) |     |             |     |             |       |             |        |
|---------------------|---|-----|-------------|-----|-------------|-------|-------------|--------|
|                     | Soil pH                                       |     | Available N |     | Available P |       | Available K |        |
|                     | FP  | DP  | FP          | DP  | FP          | DP    | FP          | DP     |
| Aotsakili           | 6.3   | 6.5 | 245         | 293 | 9.18        | 38.40 | 109.81      | 230.40 |
| Sumi Settsu         | 6.1   | 6.3 | 230         | 287 | 14.07       | 34.12 | 100.23      | 125.12 |
| Mean                | 6.2   | 6.4 | 237.5       | 290 | 11.63       | 36.26 | 105.02      | 177.76 |

FP= Farmers Practice, DP= Demonstrated Plot

liming has enhanced higher yield in maize. Kovačević and Rastija [11] observed increased in yield of maize and barley with lower dose of lime (Dolomite) for several years in acidic soil with pH 3.78. Miranda et al. [12], also reported significant response in grain yield of corn and soybean with the increasing levels of lime from 2 t ha<sup>-1</sup> onwards in acid soils. Use of liming materials such as Calcium Carbonate (CaCO<sub>3</sub>), Oyster Shell Ash (OSA), Palm Bunch Ash (PBA), Kitchen Residues Ash (KRA) and Saw Dust Ash (SDA) each, at five levels: 0, 2, 4, 6 and 8 tonnes per hectare in acid soil positively increased the growth parameter and yield of maize [13].

The cost of cultivation was a little higher in the demonstrated plots as compared to farmer's practice due to the cost incurred in purchased of lime, labour and transportation. However the application of lime fetched higher mean net return of Rs. 11324.45 and B:C ratio of 2.6 over farmers practice of Rs. 6986.34 and 2.2. Kumar et al. [9] also reported significant increased in gross income, net return and B:C ratio of ricebean with the application of 0.6 t ha<sup>-1</sup> of lime. There was also significant increased in the quality parameters with the lime application in ricebean. The mean soil available N, P and K and soil pH in the demonstration plots after crop harvest was found to be increased viz., 290, 36.26, 177.76 kg ha<sup>-1</sup> as compared to farmers practice (Table 2). Liming at higher rates at the soil depth of 0-10 cm and 10-20 cm results in higher concentration of ammonium-N [14]. Application of lime in acidic soil also increases the soil pH from 5.0 to 6.5, thereby enhancing phosphorus availability by releasing P ions from Al and Fe oxides [15]. Available soil potassium

supply to the plants is also increased due to greater concentration of potassium held on the cation exchange capacity of the soil as the pH rises [16].

#### 4. CONCLUSION

Therefore from the above observation, it was reported that farmers need to be sensitized on soil acidity and how to reclaim it to increase the crop productivity by adjusting the soil pH. It is concluded that liming is an important ameliorant to reclaim soil acidity and improve soil health and productivity of maize in the jhum fields under Zunheboto district of Nagaland.

#### COMPETING INTERESTS

Author has declared that no competing interests exist.

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