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# Study on the soil acidity and lime requirement in jhum fields under rice cultivation

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**Abstract**
A Study on the soil acidity and lime requirement in jhum fields under rice cultivation was undertaken during 2016-17 in the Department of Agricultural Chemistry and Soil Science, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Nagaland. Altogether 30 surface soil samples in rice jhum fields from 15 villages under Sitimi block of Kiphire district were collected for the study. The pH the soils of different villages under Kiphire district ranged from 5.03- 6.08. The values of OC ranged from 0.96-5.86. Available N, P and K ranged from 150.53-602.11 kg $ha^{-1}$, 4.10-28.21 kg $ha^{-1}$ and 121.50-218.27 kg $ha^{-1}$ respectively. The total acidity, exchange acidity and pH dependent acidity varied from 0.53-3.01 c mol (p+) $kg^{-1}$, 0.13-2.00 c mol (p+) $kg^{-1}$ and 3.60-14.43 c mol (p+) $kg^{-1}$ respectively. Lime requirement for jhum ranged from 4.5-16.3 & 5.5-19.3 t $ha^{-1}$ to raise the soil pH to 6.0 & 6.4 respectively.

**Keywords:** jhum, total acidity, exchange acidity, ph dependent acidity and lime

## Introduction
Soil acidity is an important soil health problem which affects the yield and productivity of crops. The acid soils are found in areas of Assam, Nagaland, Manipur, Mizoram, Tripura, West Bengal, Bihar, Orissa, Kerala and Karnataka. Acid soils in India accounts for 30657.2 hectare of the total geographical area (Maji *et al*.,2012) [1]. The problems of acid soils are dominant in areas receiving heavy rainfall, acidic parent materials and hilly topography. The most commonly caused degradation of land in the Northeast region of India is due to acidification. About 7.5 lakh hectares of land in Nagaland is under acid soil which constituted 45% of the total area followed by Manipur at 6.3 lakh hectares covering 28% of the total geographical area (Sangomla, 2018) [2]. In Nagaland, jhumming is an important traditional cultivation practices since time immemorial. However, it is one of the main causes contributing to degradation of land. It is being practiced with the life cycle of 15-20 years without posing any risk because sufficient time is given for forest regeneration and maintaining soil fertility. But shortening of the life cycle to less than 10 years due to pressure of increased population on land adversely affects the soil health as well as crop yield. Soil acidity is reported to be about 80% of ASR in the NE region of India (Misra, 2004) [3]. These are due to high precipitation, weathering, acidic parent material and leaching. So liming is used to correct this soil acidity. Lime requirement may be defined as the quantity of lime sources which should be added to raise the soil pH to a determined value. Most of the crops do well at the pH range of 6-7. As a result, modern agriculture is facing a challenge of producing sufficient food for the ever increasing population in a diminishing area of land under cultivation without depleting the resources for future generation *i.e.* sustainable agriculture. Thus in order to overcome this challenge, modern agriculture should have a very in-depth knowledge about the physical and chemical properties of soil such as the fertility status, soil reaction, organic matter content etc. so that the management practices can be advocated based on the requirement of the specific crop. Thus keeping in mind the above points, this research study based on the soil acidity and lime requirement was conducted in jhum paddy fields under kiphire district of Nagaland.

## Materials and Methods
The district is located between the latitude 25°54'N to 25°9'N and longitude 94°47'E to 94°78'E having total geographical area of 1255 sq. kms, elevation of 896.42 meters above mean sea level and temperature ranges from 27-37°C. Monsoon period extends from June to September and sometimes up to October with average rainfall of 1500 to 1800mm. A single block-Sitimi was selected by random sampling and 15 villages were selected under it. The soil samples were collected from the jhum paddy fields. The composite was made by collecting three soil samples from three different respective fields of jhum land use. Collected soil samples were air-dried. Stones, pebbles, plant roots etc were removed and the soils were grounded and passed through a 2 mm sieve. About 500gm of processed soil were stored in a polyethene bag after labeling it carefully. Total acidity was determined by following the method as described by Baruah and Barthakur (1997) [4] by using 40gm of soil in 100ml 1N NaOAc solution and agitated for 1hr. The filtrate was then titrated against 0.1N NaOH using phenopthaline indicator till pink colour develops. Exchange

acidity was determined by Sokolov (1939) method as given by Baruah and Barthakur (1997) [4]. 40gm of soil sample was treated with 100ml 1N KCl solution and agitated for 10 minutes. The content was filtered and 20ml of filtrate was taken against 0.1N NaOH using phenopthaline indicator until pink colour develops. pH dependent acidity was calculated using following equation:
pH dependent acidity= Total Potential Acidity- Exchange Acidity
Lime requirement of the soils were determined using Shoemaker *et al*. method 1981 as described by Baruah and Barthakur (1997) [4]. This involved determination of pH of soil in extraction buffer solution using glass electrode pH meter.

## Results and Discussion

### Soil acidity

Total acidity

Total acidity (TA) is present in the soil in measurable quantity as hydroxyl-Al polymers and comprises of pH dependent acidity and exchange acidity. The details of the values of the Total acidity for various soil samples of jhum under rice cultivation are given in the Table 1. The total acidity of the soils under Kiphire district ranged from 0.85-3.01 cmol (p+) $kg^{-1}$ in jhum. The total acidity was observed highest in new Monger (3.01) followed by Yangphire (2.85), Phisami (2.50) and least in Langzar (0.85). The higher TA in jhum may be attributed to high amount of organic carbon and exchangeable Al content. Sharma *et al.*, (1990) [5] and Tsanglao (2014) [6] also made similar observations in acid soils of India.

### Exchange acidity

The exchange acidity (EA) is the sum total of H+ and Al3+ retained on the soil exchange complex and it replenishes into the soil solution whenever the soil solution concentration gets depleted. It constitutes a significant part of the total acidity. The EA of the soils in the district ranged from 0.25-2.00 cmol (p+) $kg^{-1}$ in jhum which is lower than the total acidity value. The highest EA in jhum was observed in Natsami (2.00) followed by Yangphire (1.32), Phisami (1.25) and least in Old Monger (0.25) with the mean of 0.76 cmol (p+) $kg^{-1}$. It is observed that it contributes lesser to the total acidity. Sarangthem *et al*. (2017) also reported lesser contribution of exchange acidity towards total acidity in Bishnupur district of Manipur. The details of the values of the exchange acidity for various soil samples of jhum under rice cultivation are given in the Table 1.

### pH dependent acidity

The pH dependent acidity comprises of the acidity manifested from the dissociation of protons from the functional groups viz., weaker carboxyl group and most of the phenolic hydroxyl group on the soil matter as well as weak acid protons in the soil mineral edges due to increase in the soil pH. The details of the values of the pH dependent acidity for various soil samples of jhum under rice cultivation are given in the Table 1. The pH dependent acidity of soils ranged from 7.60-14.43 cmol (p+) $kg^{-1}$ in jhum. The highest pH dependent acidity for jhum was observed in Phisami (14.43) followed by Yangphire (13.79), Thangthure (13.28) and least in Old Monger (7.60). The mean value pH dependent acidity for jhum was 12.07 cmol (p+) $kg^{-1}$. The high pH dependent acidity is due to the presence of high organic carbon. Gangopadhyay *et al*. (2008) [8] also observed that the pH dependent acidity increases in the presence of organic carbon and free Fe oxides.

### Lime requirement

Lime is Calcium carbonate or CaCO3 used in the soil with low pH to reclaim the acidic soil. It removes the excess of H+ ions and raises the pH to desired level. Apart from this it also adds a secondary nutrient Ca to the soil. The details of the values of the LR for various soil samples of jhum under rice cultivation are given in the Table 2. From the table it is evident that the LR to raise the pH of the soils to 6.0 & 6.4 under jhum cultivation varied from 4.5-16.3 t $ha^{-1}$ & 5.5-19.3 t $ha^{-1}$ with mean of 12.03 t $ha^{-1}$ & 14.37 t $ha^{-1}$. The highest LR under jhum cultivation was observed in Shothumi with 16.3 t $ha^{-1}$ & 19.3 t $ha^{-1}$ and lowest in Sitimi with 4.5 t $ha^{-1}$ & 5.5 t $ha^{-1}$ to raise the pH to 6.0 & 6.4 respectively. The high value of lime requirement in jhum may be attributed to the acidic nature of the soils of Kiphire district under rice cultivation. Similar high value LR was also reported by Tsanglao (2014) in the soils of Wokha district under different land use system

**Table 1:** Soil acidity under rice jhum cultivation in Kiphire district.

| Sl. No | Name of the village | Total acidity [cmol(p+) $kg^{-1}$] | Exchange acidity [cmol(p+) $kg^{-1}$] | pH dependent acidity [cmol(p+) $kg^{-1}$] |
|---|---|---|---|---|
| 1 | Shothumi | 2.20 | 1.05 | 12.98 |
| 2 | Phisami | 2.50 | 1.25 | 14.43 |
| 3 | Lukhami | 2.02 | 0.53 | 11.95 |
| 4 | Yangzitong | 1.65 | 0.31 | 11.13 |
| 5 | Sitimi | 2.10 | 0.88 | 12.27 |
| 6 | Nitoi | 1.85 | 0.38 | 11.49 |
| 7 | Thazuvi | 2.01 | 0.43 | 12.95 |
| 8 | Langzar | 0.85 | 0.32 | 8.78 |
| 9 | Natsami | 1.54 | 0.88 | 12.75 |
| 10 | Old Monger | 0.92 | 0.25 | 7.60 |
| 11 | New Monger | 3.01 | 2.00 | 14.08 |
| 12 | Thangthure | 2.10 | 0.81 | 13.28 |
| 13 | Yangphire | 2.85 | 1.32 | 13.79 |
| 14 | Honito | 1.25 | 0.56 | 11.93 |
| 15 | Tsungar | 1.08 | 0.42 | 11.64 |
| Mean | | 1.86 | 0.76 | 12.07 |

**Table 2:** Lime requirement in rice jhum field under Kiphire district.

| Sl. No | Name of the village | Lime requirement (t $ha^{-1}$) | |
|---|---|---|---|
| | | For raising pH to 6.0 | For raising pH to 6.4 |
| 1 | Shothumi | 16.3 | 19.3 |
| 2 | Phisami | 15.0 | 18.0 |
| 3 | Lukhami | 12.0 | 14.3 |
| 4 | Yangzitong | 12.0 | 14.3 |
| 5 | Sitimi | 4.5 | 5.5 |
| 6 | Nitoi | 12.0 | 14.3 |
| 7 | Thazuvi | 12.0 | 14.3 |
| 8 | Langzar | 8.8 | 10.8 |
| 9 | Natsami | 13.0 | 15.5 |
| 10 | Old Monger | 12.0 | 14.3 |
| 11 | New Monger | 9.8 | 11.8 |
| 12 | Thangthure | 13.0 | 15.4 |
| 13 | Yangphire | 12.0 | 14.3 |
| 14 | Honito | 15.0 | 18.0 |
| 15 | Tsungar | 13.0 | 15.5 |
| Mean | | 12.03 | 14.37 |

## Conclusion

From the study of soil acidity and lime requirement in paddy jhum fields under kiphire district, Nagaland, it is observed that the soils are acidic in reaction. The Organic Carbon of the soils were also high and soil available N was medium to high in jhum, P was low to medium in jhum and K was medium in jhum. From the research data it is also evident that the soils of Kiphire district have problem of acidity which needs to be reclaimed by adding recommended dose of $CaCO_3$ to improve soil health and crop productivity.

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