STATUS OF ZINC AVAILABILITY IN JHUM FIELDS UNDER RAINFED CONDITION IN ZUNHEBOTO DISTRICT OF NAGALAND.

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Abstract

The Zinc deficiency in the soil is spreading worldwide. It can lead to decrease in soil fertility, crop yield and productivity. It is an essential micronutrient required for plants and an important dietary nutrient for the wellbeing of human beings and animals. In Nagaland, its deficiency is slowly increasing and several factors such as shifting cultivation which is also known as slash and burn, forest fire, leaching and run off and nutrient exhaustion in the soil by the crop may be attributing to its deficiency in the soil. As Zinc deficiency is rapidly increasing all over, a soil survey on zinc availability was conducted in 83 jhum fields under rainfed condition covering 7 villages of Zunheboto district of Nagaland during 2016-17. The soil samples were collected from the field using GPS and were analysed using standard procedure. It was observed that the Zinc deficiency ranged from 0.26 to 0.55 mg kg^{-1} which indicated that its deficiency is found widespread in this part of the region. Zinc being an important micro nutrient for growth and yield of crops, timely nutrient management through balanced fertilization will enhanced soil fertility and crop productivity.

Key words: Jhum field, Nagaland, soil fertility, Zinc

Introduction

Zinc is an important micronutrient for plant growth and nutrition. Its deficiency is about 36.5% in Indian soil. This micronutrient is required in small amount but in inadequate condition, it will cause physiological stress in plants (Alloway B. J., 2008). The available Zinc is also low in about 30% of the cultivated soils in the world (FAO) and its deficiency is found all over the world. It is considered the fourth most yield limiting nutrient for crops in India. Zinc deficiency is likely to increase from 49 to 63% in Indian soils by 2025 (Arunachalam *et al*., 2013).

It plays an important role for various enzymatic actions required for protein synthesis, nitrogen metabolism and energy transfer in animals as well as human beings too. There are about 3 billion people around the world suffering from zinc deficiency. This condition is prevalent in areas where people are constantly depending on a particular cereal diet. The recommended daily intake of 15 mg Zinc per day is required for overall growth and immune systems in humans. Deficiency of zinc leads to memory loss, hair and skin problems, weakness in body muscles, infertility, stunted brain development of the fetus and congenital diseases.

In plants with zinc deficiency, protein, carbohydrate and chlorophyll formation is significantly reduced. Zinc deficiency in plants causes stunted growth, chlorosis, spikelet sterility, water uptake and transport in plants. It plays a key role in the production of growth hormone auxin.

The micronutrient deficiencies are prevalent in the North east region of India and it varies from one location to another due to varying climatic condition, topography and soils (Barthakur et al., 1998, Baruah et al., 2014, Bhowmick et al., 1999) . It is also relevant that the crop production in this region is lacking behind with the rest of the other region which may be due to micronutrient deficiency and acidity in soil. Wang et al., 2015 also reported that soil pH and nutrient leaching are major limiting factors that affects yield. The yield decline in an intensified cropping systems is mainly due to micronutrient deficiencies (Katyal and Rattan, 2003). The Zinc deficiency problem has been rapidly increasing due to lack of knowledge on Zinc responsiveness and use of highly zinc susceptible crop variety.

The deficiency of Zinc in Nagaland is also increased by 4.62 % (Shukla, 2018). There are several factors causing zinc deficiency in this areas such as shifting cultivation, excessive leaching (Bandyopadhyay *et al.*, 2018) , run off and forest fire that leads to decline in fertility of top soil (FAO) which may attribute to the zinc deficiency in this region. The continuous removal of the nutrient by the crop without replenishing it also leads to zinc deficiency. However, there is limited information on micronutrients and its availability in this part of the region (Chen et al., 2002). Therefore further research is needed to understand the cause of its deficiency.

Keeping the limitation of Zinc availability in mind, this soil survey was conducted in 83 jhum fields covering 7 villages under zunheboto district of Nagaland.

Materials and methods

The climatic condition of the soil surveyed areas varies from sub tropical to temperate climate with temperature falling between 8 – 32 ^{o}C and annual mean rainfall of 200 mm. The soil order falls under inceptisols and ultisols. The soil type ranges from sandy loam to clay loam (table. 1). The acidity of soil ranged from strongly acidic to slightly acidic with low to medium organic carbon, low available phosphorus, medium in available nitrogen and potassium. Altogether 83 soil samples were analysed using GPS. The soil samples were collected from a 15cm depth during the year 2016-17. The soils were turned into powder form and then sieved. The soil pH was measured using the procedure given by Jackson (1973). Soil organic carbon (OC) was estimated using potassium dichromate and sulphuric acid (Jackson 1973). Soil texture was estimated using hydrometer method. Available nitrogen (N) was measured using KMnO4 by distillation method (Subbiah and Asija 1956). Available phosphorus (P) was extracted by Bray and Kurtz No.1 extractant which was determined spectrophotometerically (Jackson 1973).

Available potassium (K) was extracted by neutral normal ammonium acetate using flame photometer. The available Zinc in the soil was determined with 0.005 M DTPA extractant using the atomic absorption spectrophotometer given by Lindsay and Norvell (1978).

Results and discussion

Zinc deficiency was found in all the 7 villages. Its deficiency ranges from 0.26 to 0.55 mg kg^{-1} in the jhum fields (table 2). The highest Zinc deficiency was seen in Aotsakili followed by Lumithsami village. Eventhough the rate of deficiency of Zinc differs from one location to another, however from the soil samples that were analysed, it showed that Zinc deficiency is spread over a large part of this location. Several factors may be responsible for causing Zinc deficiency such as traditional practice of shifting cultivation has lead to gradual decrease in the soil bases and further decline in soil fertility. The heavy rainfall in this region is also another factor that leads to loss of nutrients due to leaching and runoff causing micronutrient deficiency . The total Zinc status is low in sandy, highly leached and weathered acidic soil (Alloway B. J., 2008). These may be the reason for Zinc deficiency in the surveyed area as the soil is acidic in reaction with soil pH ranging from 5.5 to 6.0. The soil available Zinc varies from 0.26 to 0.55 mg kg^{-1} with an average content of 0.38±0.10 mg kg^{-1} . These may be due to leaching out of the water soluble Zinc from the acidic upland soils. Similar finding was reported by Kumar *et al*., (2018) due to heavy precipitation in the acidic uplands. The lowest soil available Zinc of 0.26 mg kg^{-1} was found at OC 0.63%. Zinc deficiency is also observed in areas with low organic carbon content as the Zinc availability may also be decreased due to low soil organic carbon content in the rainfed region (Srinivasarao *et al*, 2009).

Continuous cropping with Zinc requiring crop also leads to depletion of soil available Zinc, if the nutrient source is not applied in the soil. In India, the loss of yield due to lack of Zinc fertilizer application is about 10% as reported by Shukla *et al* (2009). It is a major productivity constraints faced in the rainfed farming areas (srinivasarao *et al*., 2012a, 2012b).

Table 1: Characteristics of soil and climate of the survey sites.

Village	No. of field samples	Location	Soil order	Mean annual rainfall	Temperature	Soil texture

				(cm)		
Sumi Settsu	13	26⁰15′44″N 94⁰28′88″E 26⁰15′42″N 94⁰28′85″E 26⁰15′54″N 94⁰28′75″E 26⁰15′44″N 94⁰28′67″E	Inceptisol	200	8-32	Sandy loam
Zaphumi	10	26⁰13′54″N 94⁰27′55″E 26⁰13′57″N 94⁰28′03″E 26⁰13′53″N 94⁰27′35″E 26⁰13′50″N 94⁰27′09″E	Inceptosol	200	8-32	Sandy loam
Lumami	10	26⁰13′54″N 94⁰27′55″E 26⁰13′57″N 94⁰28′03″E 26⁰13′53″N 94⁰27′35″E 26⁰13′50″N 94⁰27′09″E	Inceptisol	200	8-32	Sandy loam
Alaphumi	14	26⁰11′795″N 94⁰27′80″E 26⁰11′71″N 94⁰27′89″E 26⁰11′92″N 94⁰27′79″E 26⁰11′85″N 94⁰27′71″E	Inceptisol	200	8-32	Sandy loam
Aotsakili	16	26⁰05′37″N 94⁰30′55″E 26⁰05′23″N	Ultisol	200	8- 32	Clay loam

		94^{0}31′09″E 26^{0}05′46″N 94^{0}31′27″E 26^{0}05′54″N 94^{0}31′08″E				
Lumithsami	9	26^{0}11′39″N 94^{0}29′52″E 26^{0}11′23″N 94^{0}30′06″E 26^{0}11′38″N 94^{0}30′22″E 26^{0}11′56″N 94^{0}30′21″E	Inceptisol	200	8-32	Sandy loam
Litta New	11	26^{0}15′53″N 94^{0}37′98″E 26^{0}15′36″N 94^{0}37′87″E 26^{0}15′23″N 94^{0}38′05″E 26^{0}15′26″N 94^{0}38′20″E	Inceptisol	200	8- 32	Sandy loam

Table 2: Status of Zinc availability in different jhum fields under Zunheboto district.

Location	Soil pH	Organic carbon	Zn (mg kg^{-1})
Sumi Settsu	6.0	1.26	0.45
Zaphumi	6.0	0.69	0.52
Lumami	5.7	0.97	0.30
Alaphumi	6.0	1.39	0.55
Aotsakili	5.5	0.63	0.26

Lumithsami	5.9	0.94	0.29
Litta New	5.7	0.93	0.32
Mean	5.8	0.97	0.38
Range	0.5	0.76	0.29
S.D±	0.2	0.28	0.10

Conclusion

From the survey conducted, it was observed that Zinc deficiency in soil increases with low pH and organic carbon. Its deficiency is widely found all over in all types of soils. Zinc deficiency is expected to increase 63% by 2025 (Srinivasarao *et al*., 2013). It is an essential micro nutrient for a multiple range of crops. Therefore correcting this nutrient deficiency will be an important measure to enhance the soil health and crop productivity in the jhum upland fields of the Zunheboto district of Nagaland.

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