# Effect of Seasonal Variation on Soil Chemical Properties and Soil Enzyme Activity in Wetland Paddy Fields of Buhchangphai, Kolasib District, Mizoram, India

**Article** · July 2021

CITATIONS
0

READS
15

**3 authors**, including:

Lal Biakdika
Mizoram University
**5** PUBLICATIONS **2** CITATIONS
SEE PROFILE

F Lalnunmawia
Mizoram University
**9** PUBLICATIONS **142** CITATIONS
SEE PROFILE

# *Effect of Seasonal Variation on Soil Chemical Properties and Soil Enzyme Activity in Wetland Paddy Fields of Buhchangphai, Kolasib District, Mizoram, India*

Lalbiakdika, F. Lalnunmawia and
H. Lalruatsanga

Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 12
Issue: 04

Res Jr of Agril Sci (2021) 12: 1129–1132

CARAS

Res. Jr. of Agril. Sci. (July-Aug 2021) 12(4): 1129–1132
www.rjas.org

*Full Length Research Article*

# Effect of Seasonal Variation on Soil Chemical Properties and Soil Enzyme Activity in Wetland Paddy Fields of Buhchangphai, Kolasib District, Mizoram, India

Lalbiakdika[1], F. Lalnunmawia[2] and H. Lalruatsanga*[3]

Received: 30 Apr 2021 | Revised accepted: 09 Jun 2021 | Published online: 02 July 2021


## A B S T R A C T

Investigations were carried out on the effect of seasonal variation on soil chemical properties and soil enzyme activity during 2020. A total of fifteen samples were collected during pre-planting (April), growing (August), and post-harvest (December) of paddy. A total of fifteen samples were collected from various places of paddy fields, and soil fertility indicators like pH, soil organic carbon (SOC) total nitrogen (N), available phosphorus (P), available potassium (K), and soil enzymes viz. dehydrogenase, phosphatase and urease activity were analyzed. Soil organic carbon was found highest during post-harvest and found to be lowest during pre-planting of paddy. Soil macronutrients like available phosphorus (P), available potassium (K) and total nitrogen (N) were found to be highest during the growing season and followed by post-harvest and lowest during pre-planting of paddy. Soil enzyme activity of the study area shows the same pattern i.e., highest during growing season followed by post-harvest and lowest during pre-planting of paddy.

***Key words*:** Buhchangphai, Soil fertility, Soil enzyme activity, Wetland paddy field

Assessment of soil quality is crucial to the recommendation of management practices for soil improvement and plays a pivotal role in achieving and promising the yield of the crops. Soil fertility and quality decline with intensive farming and it cannot last long unless managed properly. Wetland paddy soil is anthropogenic and its evolvement and formation are affected greatly by water, fertilizer management and tillage. Flooding in rice paddies favoured the decomposition of organic materials resulting in high Soil organic carbon contents in the long term [1]. Agricultural production depends on the physico-chemical properties of the soil used for it. Quantity of three main soil nutrients viz. Nitrogen (N), Phosphorus (P), and Potassium (K) dependent on crop type and plant growth status. Assessment of the present status of NPK nutrients in the soil will suggest that how much quantity of fertilizer to be used for crop growth and development. Seasonal variation in soil fertility and quality are due to factors such as climate pattern, cropping sequences, and farming systems. Availability of soil nutrients and crop productivity is determined by qualitative and quantitative change in soil enzyme activities [2-3].

Optimum application of plant nutrients increases dehydrogenase activity (DHA) that indicates an oxidative activity of soil microbes. The source of nutrients applied also affects DHA and the activity is more with organic nitrogen sources as compared to mineral nitrogen [4]. Soil receiving a high rate of nitrogen either as chemical fertilizer alone or in combination with an organic cropping system has shown high Urease activity [5]. Freshly collected soils from the fields are preferred for microbiological studies [6] and parameters are to be measured as soon as possible after soil sampling. However, this is not always possible for a practical reason, and refrigeration at 4°C for a maximum of three months is recommended when storage is required [7-8]. The objective of the present study is to determine and compare soil nutrients status and enzyme activity during different cropping seasons such as pre-planting, growing, and post-harvest of paddy in the wetland paddy fields of Buhchangphai, kolasib district, Mizoram.

## MATERIALS AND METHODS

A field experiment was carried out in the lowland paddy field of Buhchangphai, Kolasib, Mizoram, India. Geographically it is located between 24°20’10.7” N latitude, 92°39’26.7” E longitude with an altitude 48 meters above

* H. Lalruatsanga
✉ biakdikahmar191@gmail.com

[1-2] Department of Botany, Mizoram University, Tanhril - 796 004, Mizoram, India

[3] Department of Botany, Pachhunga University College, Aizawl - 796 001, Mizoram, India

sea level. The climatic condition is classified as temperate and warm. The average temperature ranges from 10-38°C. It is directly influenced by the southwest monsoon and receives an adequate amount of rainfall during the monsoon season. The average rainfall is 2805mm per annum and the highest rainfall was recorded during July and August.

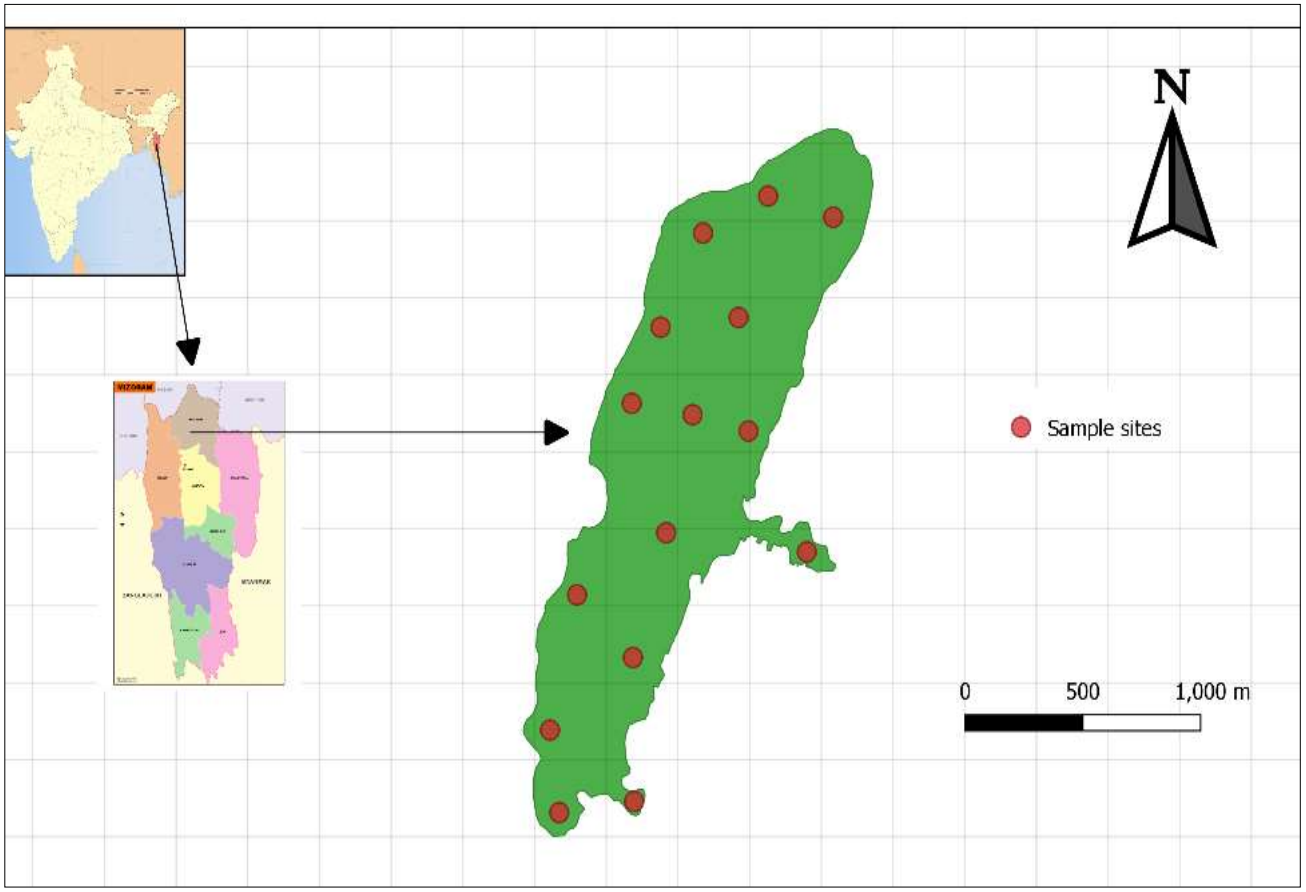


Fig 1 Location map showing sample sites

*Soil sampling and analysis*

Soil samples in the study area were randomly collected from 0-15 depth. A total number of thirty (30) samples were collected during pre-planting (April), growing (August) and post-harvest (December) of paddy from different paddy fields. The samples were preserved in a transparent polythene bag and each bag was labelled. An icebox was used to transport the samples to maintain moisture level and stored in the refrigerator at 4°C. Soil samples were dried in the laboratory and then sieved through a 20-mesh sieve (< 2mm diameter) to make the sample suitable for chemical analysis.

Soil pH was determined by glass electrode and soil moisture content (SMC) was determined by using the method of Bashour and Sayegh [9]. Soil organic carbon (SOC) and soil organic matter (S)M) was determined by Walkey and Black's chromic acid wet oxidation methods [10]. The total nitrogen (N) content of the study area was measured by the micro-Kjeldahl digestion method. Care was taken during digestion to prevent loss of nitrogen. The ammonia ($NH_3$) from the digestion was distilled with 40% NaOH and 4% Boric acid and determined by titrating with 0.02N $H_2SO_4$ [11]. Available phosphorus (P) was determined calorimetrically by the method described by Olsen *et al.* [12] and a flame photometer was used to measure available potassium (K) [13].

Soil enzymes – dehydrogenase, phosphatase and urease activities were determined by using methods described by [14], [15] and the buffer method of Kandeler and Gerber [16] respectively.

*Statistical analysis*

Data were analyzed with the help of statistical package for the Social Sciences (SPSS: version-16) and Microsoft Office Excel. All data are presented as means of three replicates with standard error. Differences between variables were analyzed with Standard one-way analysis of variance (ANOVA). Differences were considered significant at $P<0.05$ levels.

## RESULTS AND DISCUSSION

The soil parameters were studied during three different seasons in a year viz. pre-planting (April), growing (August), and post-harvest (December) of paddy. The study showed that all parameters varied under the influence of seasonal variations. The pH of the study areas was found to be slightly acidic in nature. The highest value of pH was found during pre-planting (5.79) followed by post-harvest (5.32) and lowest during the growing season of paddy (5.08). The low value of pH during a growing period may be due to the high decomposition of organic matter which releases acidic elements like hydrogen, manganese, and aluminium to replace bases. Soil pH is found to be a positive correlation with soil moisture content.

Soil organic carbon and the soil organic matter were found highest during post-harvest (1.41% and 2.42%) followed by growing (1.15% and 1.98%) and lowest during pre-planting of paddy (0.85% and 1.46%). It is assumed that organic matters contain 58% organic carbon and therefore, soil organic matter is calculated by multiplying soil organic carbon (%) by 1.72. According to BARC, 2005 and SRDI, 1985, good soil should have at least 2.5% organic matter but the average organic matter content in the study area was slightly lower and ranges from 1.21% - 1.68% (M=1.46%), 1.77% - 2.13% (M=1.98%) and 2.18% - 2.88% (M=2.42%) during pre-planting, growing and post-harvest of paddy respectively.

Other soil macronutrients like available phosphorus (P), available potassium (K), and total nitrogen (N) were found to be highest during the growing season and followed by post-harvest, and lowest during pre-planting of paddy (Table 1). The high concentration of soil macronutrients during the growing season could be attributed to the high decomposition and application of NPK fertilizers.

Table 1 Soil chemical properties

| Soil properties | Pre-planting | Growing | Post-harvest |
|---|---|---|---|
| Soil pH | 5.79 ± 0.09 | 5.08 ± 0.02 | 5.32 ± 0.02 |
| Soil moisture content (%) | 14.23 ± 0.76 | 62.11 ± 1.09 | 31.4 ± 0.82 |
| Soil organic carbon (%) | 0.85 ± 0.02 | 1.15 ± 0.02 | 1.41 ± 0.04 |
| Soil organic matter (%) | 1.46 ± 0.04 | 1.98 ± 0.04 | 2.42 ± 0.07 |
| Total nitrogen (%) | 0.114 ± 0.00 | 0.25 ± 0.01 | 0.17 ± 0.00 |
| Available phosphorus(kg/ha) | 6.99 ± 0.57 | 16.77 ± 0.45 | 13.33 ± 0.48 |
| Available potassium (kg/ha) | 153.88 ± 8.76 | 310.18 ± 6.21 | 252.04 ± 3.81 |

Table 2 Soil enzyme activity

| Enzymes | Pre-planting | Growing | Post-harvest |
|---|---|---|---|
| Dehydrogenase (µg TPF/gm dry soil/24hrs) | 0.099 ± 0.002 | 0.698 ± 0.01 | 0.279 ± 0.004 |
| Phosphatase (µg p-NPP/gm dry soil/hr) | 71.97 ± 0.98 | 153.98 ± 1.48 | 97.72 ± 1.25 |
| µg $NH_4$-N (g soil)$^{-1}$ (2 h)$^{-1}$; | 28.46 ± 1.09 | 94.41 ± 2.65 | 49.87 ± 1.53 |

The optimum limits of a percentage of total nitrogen (N) are four categories such as low (<0.180%), medium (0.180%-0.360%), high (0.360%-0.450%), and very high (>450%). Total nitrogen (N) content in the study area falls under low during pre-planting (0.114%) and post-harvest of paddy (0.17%) whereas a moderate level of total nitrogen was found during the growing of paddy (0.25%) [17]. Available phosphorus (P) content into five category such as very low (<5 kg/ha), low (5-10 kg/ha), medium (10-20 kg/ha), high (20-40 kg/ha) and very high (>40 kg/ha) [12]. A moderate level of available phosphorus (P) was found during the growing season (16.77 kg/ha) and post-harvest of paddy (13.33 kg/ha). Available phosphorus (P) of the study area falls under low level during pre-planting of paddy (6.99 kg/ha). Optimum level of available potassium (K) is five categories such as very low (<200K kg/ha), low (200-250K kg/ha), medium (250-400K kg/ha). High (400- 600K kg/ha) and very high (>600K kg/ha). Available potassium (K) content of the study falls under low during pre-planting of paddy (153.88 kg/ha), moderate level of available potassium (K) was found during growing season 310.18 kg/ha) and post-harvest of paddy (252.04 kg/ha) [13].

Soil enzymes are necessary catalysts for recycling organic matter and strongly influence soil fertility. Soil enzyme activity of the study area (Table 2) shows the same pattern i.e., highest during growing season followed by post-harvest and lowest during pre-planting of paddy. Soil moisture is the key factor affecting soil microbial activity and therefore soil moisture content is a positive correlation with enzyme activity. Enzyme activity is closely related to soil organic matter (SOM) whereas it is negatively in correlation with soil pH. They have varying optimum pH and temperature at which they function most efficiently [18]. The hot and cold temperature of the soil can alter their substrate binding ability. Most of the study fields received high nitrogen treatment from fertilizer during the growth of paddy, high nitrogen treatment may increase enzyme activity during the growing season [4].

Table 3 One-way analysis of variance (ANOVA)

| Parameters | Source of variance | f-vale | p-value |
|---|---|---|---|
| Soil moisture content | Pre-planting × Growing × Post harvest | 456.91 | <0.00001 |
| Soil pH | -do- | 111.896 | <0.00001 |
| Soil organic carbon | -do- | 72.374 | <0.00001 |
| Soil organic matter | -do- | 71.589 | <0.00001 |
| Total nitrogen | -do- | 85.193 | <0.00001 |
| Available phosphorus | -do- | 113.547 | <0.00001 |
| Available potassium | -do- | 144.681 | <0.00001 |
| Dehydrogenase | -do- | 766.470 | <0.00001 |
| Phosphatase | -do- | 1087.516 | <0.00001 |
| Urease activity | -do- | 319.819 | <0.00001 |

## CONCLUSION

The comparative study on soil chemical properties and enzyme activities of Buhchangphai paddy fields during three seasons viz. pre-planting, growing, and post-harvest of paddy showed significance (<0.05) variation among all parameters. Therefore, it can be assumed that different seasonal pattern has effects on chemical properties and

enzymes activities of the soil. From the results and discussion, it is suggested that soil testing should be conducted regularly to monitor the soil fertility level for rice plantations primarily for nitrogen, phosphorus, and potassium levels. Application of Calcium carbonate, $CaCo_3$ (agricultural lime) is recommended for the soil pH lower than 5.5, and fertilizer should be applied if the nutrients status is low for optimum yield.

## LITERATURE CITED

1. Xu JZ, Yang SH, Peng SZ, Wei Q, Gao XL. 2013. Solubility and leaching risks of organic carbon in paddy soils as affected by irrigation managements. *The Scientific World Journal* 2013: 1-9.
2. Rabbi SMF, Roy BR, Miah MM, Amin MS, Khandakar T. 2014 Spatial variability of physical soil quality index of an agricultural field. *Applied and Environmental Soil Science* 2014. https://doi.org/10.1155/2014/379012
3. Srinivasarao C, Lal R, Kundu S, Prasad Babu MBB, Venkateswarlu B, Singh AK. 2014. Soil carbon sequestration in rainfed production systems in the semiarid tropics of India. *Sci. Total Environ*. 487: 587-603. DOI: 10.1016/j.scitotenv.2013.10.006.
4. Basu M, Mahapatra SC, Bhadoria PBS. 2011. Influence of soil ameliorants, manures and fertilizers on bacterial populations, enzyme activities, N fixation and P solubilization in peanut rhizosphere under lateritic soil. *Br. Microbiol. Res. Journal* 1: 11-25.
5. Pajares S, Gallardo GF, Masciandaro G, Ceccanti B, Etchevers JD. 2011. Enzyme activity as an indicator of soil quality in degraded cultivated acrisols in the Mexican trans volcanic belt. *Land Degrad. Development* 22(3): 373-381.
6. Stenberg B, Johansson M, Pell M, Sjodahl S, Sterstrom J, Toestensson L. 1998. Microbial biomass and activities in soil as affected by frozen and cold storage. *Soil Biology and Biochemistry* 3: 393-402.
7. ISO 10381-6. 1993. Soil quality-sampling. Guidance on the collection, handling and storage of soil for the assessment of aerobic microbial processes in the laboratory.
8. OCDE. 1995. Final Report of the OCDE Workshop on selection of Soils/Sediments, Belgirate, Italy. pp 18-20.
9. Bashour I, Sayegh AH. 2007. Methods of analysis for soils of arid and semi-arid regions. *Food and Agri-culture Organization of the United Nations. Rome*. pp 15-37.
10. Walkey AJ, Black IA. 1934. Estimation of soil organic carbon by chromic acid titration method. *Soil Science* 37: 29-38.
11. AOAC. 1995. Official method of analysis. 16th Edition. Association of Official Analytical Chemists, Washington, DC.
12. Olsen SR, Cole CV, Watanabe FS, Dean LA. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *Circ. U.S. Dept. Agriculture* 939: 1-19.
13. Black CA. 1965. Methods of soil analysis Part I AM. Soc. Agron. Inc. Publication, Madison Wisconsin USA.
14. Casida LE. 1977. Microbial metabolic activity in soil as measured by dehydrogenase determinations. *Applied Environmental Microbiology* 34: 630-636.
15. Tabatabai MA, Bremner JM. 1969. Use of p-nitrophenylphosphate for assay of soil phosphatase activity. *Soil Biology and Biochemistry* 1: 301-307.
16. Kandeler E, Gerber H. 1988. Short-term assay of soil urease activity using colorimetric determination of ammonium. *Biol. Fert. Soils* 6: 68-72. https://doi.org/10.1007/BF00257924
17. Hossain N, Muhibbullah M, Ali K, Molla M. 2015. Relationship between soil salinity and physico-chemical properties of Paddy Field Soils of Jhilwanja Union, Cox's Bazar, Bangladesh. *Journal of Agricultural Science* 7. 10.5539/jas.v7n10p166.
18. Srinivasrao C, Grover M, Kundu S, Desai S. 2017. *Soil Enzymes*. 10.1081/E-ESS3-120052906.