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Assessment of Seasonal Variation in Soil Characteristics within the Surrounding Area of Kolasib Solid Waste Dumping Ground

Lalmuansangi[1], Albert Vanlalliantluanga[2], VL Thachunglura[3]

[1, 2, 3] Department of Environmental Science, School of Earth Sciences & Natural Resources Management, Mizoram University
Tanhril, Aizawl Mizoram, India
[1]*mesiparte[at]gmai.com*
[2]*albertvuite41[at]gmail.com*
[3]*vlthachunglura[at]gmail.com*

Abstract: ***Soils are one of earth's critical natural resources and play a dynamic role in nourishing life on the earth. It is a mixture of gases, liquids, minerals, organic matter and organisms. This study examined the seasonal variations at monthly interval for the analysis of soil characteristics in Kolasib Town for a period of two years i.e., November 2016 to October 2018. A total of six sampling sites were prudently chosen and the monthly data were computed on seasonal basis. The soil samples were analyzed for pH, bulk density, moisture content, organic carbon, total nitrogen, phosphorus and potassium. This work aimed to investigate soil properties under different season.***

Keywords: Bulk density, seasonal variation, soil quality, solid waste, kolasib

1. Introduction

Soils are the most valuable life supporting natural resource (Venkataratnam & Manchanda, 1997) and play a dynamic role in sustaining life on the earth (Schoonover & Crim, 2015). The production of food is inherently linked to soils (Kopittke *et al*., 2019) and also acts as an important carbon reservoir (Batjes & Dijkshoorn, 1999; Pouyat *et al.*, 2002). Soil is a major source of nutrients (NPK) needed by plants for growth (Salim *et al.*, 2015).

Soils are complex mixtures of minerals, air, water, organic matter, and different organisms. Soil is the layers of generally loose mineral and organic material that are affected by physical, chemical, and biological processes at or near the planetary surface and usually hold liquids gases, and biota and support plants (van Es, 2017). Soil consists of four major components such as mineral matter45%, organic matter 5%, water 25%, and air 25% (Abdulkadir, 2017). Soil quality is the capacity of a soil to function for specific land uses or within ecosystem boundaries and this capacity is an intrinsic characteristic of a soil and varies from soil to soil. It is a measure of the soil condition relative to the requirements of one or more biotic species and human need (Johnson *et al.*, 1997). Besides air and water quality, soil quality is also one of the three components of environmental quality (Andrews *et al*., 2002).

Soil characteristics depend upon a variety of abiotic and biotic factors that vary both spatially and seasonally (Peverill et al., 1999). Long-term changes in total soil organic carbon usually occur gradually and these might be obscured by smaller, rapid changes in soil carbon due to seasonal inputs of plant residues, roots, and exudates, or decomposition of such inputs (Wuest, 2014). Seasonal variability in the soil functions and conditions are due to factors such as climate pattern, cropping sequences (Omer *et al.*, 2018), tillage management (Sacco *et al.*, 2012), changes in land-use types and the excessive use of fertilizers in agriculture have changed soil properties (Ross et al., 1999; Zhao *et al.*, 2018). Conversion of the tropical forest into pasture also changes the quality and quantity of the soil organic matter and other physico-chemical soil properties (Fernandes *et al.*, 2002).

Seasonal variation occurred in the topsoil than in lower layers (Zhang & Ding, 2007). Seasonal variation of soil quality has studied by several authors (Haines and Cleveland, 1981; DeLiberty & Legates, 2003; Roxy *et al.*, 2010; Mondal *et al*., 2015; Olatunji *et al.*, 2016; Omer *et al.*, 2018; Dłużewski *et al*., 2019) and there result show high variability changes in the soil quality. However, seasonal variation of soil quality in Mizoram is still a considerable need for research in this important area.

2. Methodology

Study Sites and Area

Kolasib district is one of the eleven districts of Mizoram state in India. The topography of the district is rough, having steep hill slopes and the comparatively low hill ranges run in the North-South direction intercepted by narrow strips of plain. It lies between 24° 13′ 52″ N and 92° 40′ 34″ E with an altitude of 722 meters (msl). It covers an area of 1,386 km². The forest cover type of the district is generally tropical wet evergreen forest and tropical semi evergreen forest linked with moist deciduous forests. The climate is naturally good; it is neither very hot nor too cold throughout the year, it is characterize by warm-wet summer and cold dry winter.

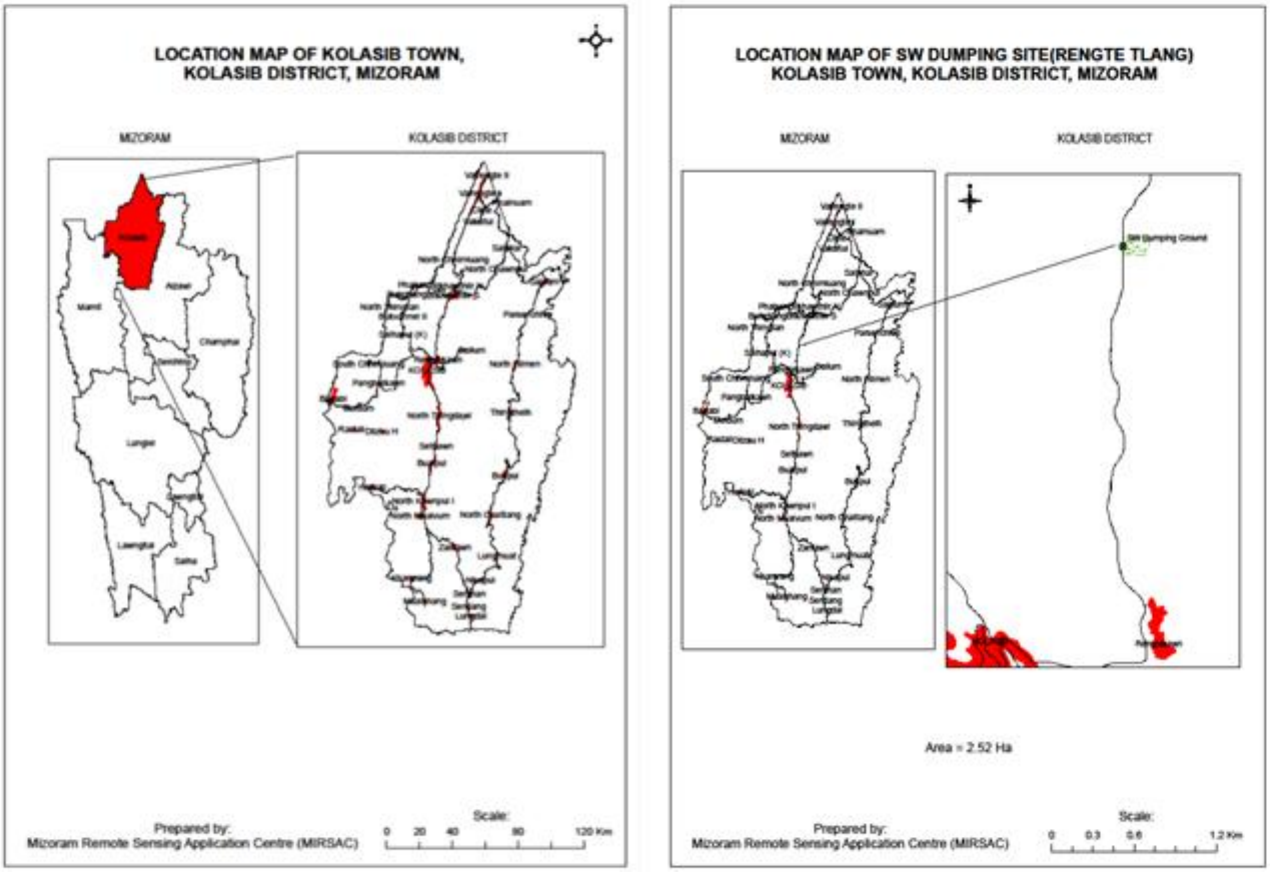

Figure: Location of Kolasib District in Mizoram

Selection of sampling sites:
A total of 6 (six) sampling sites were selected. Of this, 5 sites in solid waste dumping ground (LA1= Left corner upper side, LA2= Left corner lower side, RA1= Right corner upper side, RA2= Right corner lower side, C= Centre) and one site (CR= control/reference) outside the dumping ground where there is effect of solid waste dumping.

Collection of soil samples:
The soil samples were collected from the selected sites for a period of two years (November 2016 to October 2018) at monthly interval for analysis of soil characteristics. The monthly data were computed on seasonal basis i.e., Pre monsoon (January-April), Monsoon (May-August), Post monsoon (September to December) seasons.

Analytical method:
Soil pH was measured by using pH meter. The bulk density was estimated by dividing the dry weight of the soil material by the volume of soil. The soil moisture content was calculated by using the method given by Anderson and Ingram (1993). Soil organic carbon was determined by dichromate method (Walkley and Black, 1934). The soil total nitrogen content of the soil sample was determined by Kjeldahl Digestion Method (Anderson and Ingram, 1993). The soil phosphorous content of the study site was determined by Olsen method (Olsen *et al*., 1954) and soil exchangeable potassium was calculated given by Gupta (1999).

3. Result and Discussion

Soil pH
During the year 2016-17, minimum pH 4.7 mg/l was recorded in monsoon season at centre site and maximum during post monsoon season at control site 6.95 mg/l. Similarly, during the year 2017-18, minimum pH 4.98 mg/l was observed in monsoon season at LA1 and maximum during post monsoon season at control site 6.92 mg/l. The pH of the study site has positive and significant correlation with moisture content ($r=0.269^{**}$) and available phosphorus ($r=0.334^{**}$) ($P\leq0.01$), negative significant correlation with organic carbon ($r=-0.259^{**}$) and potassium ($r=-0.254^{**}$) at $P\leq0.01$.

From the observation, it was observed that pH value was higher during pre-monsoon and post monsoon season and lower during monsoon season. This could be due to dilution of hydrogen ion concentration by rain water which is acidic in nature. Statistical analysis proved that there is a significant change of pH between different seasons (H=0.00) ($P\leq0.05$). Among different study sites, control site has higher pH value compare to dumping site. This may be due to the formation of organic acid as a by-product of decaying organic matter. This can also be due to the acidic nature of the synthetic leachate itself. In the dumping sites, centre part has lowest pH value which is due to concentration of leachate at the central part of the dumping area that enters from different corners.

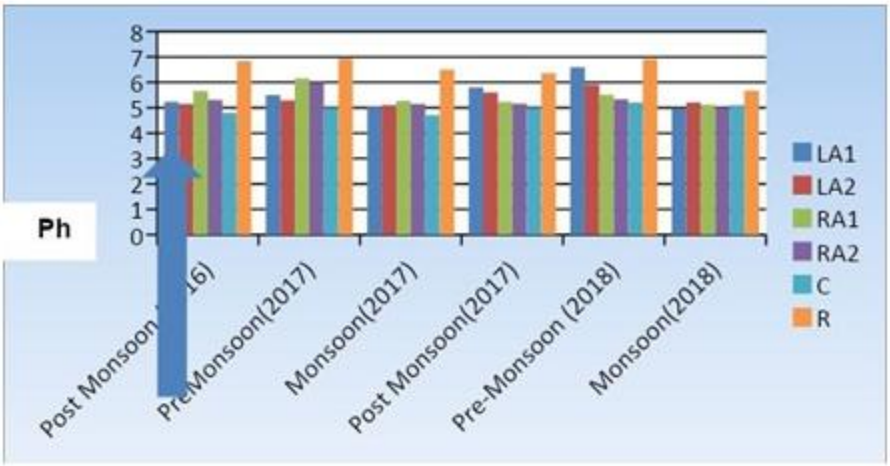

Figure 3.1: Seasonal variation in pH of soil at different sampling sites

Bulk Density

During 2016-2017, minimum value of bulk density was found at site LA1 with a value of gcm^{-3}during pre-monsoon season and maximum at control site with a value of 2.10gcm^{-3}during monsoon season and during 2017-2018, minimum value of bulk density was found at site centre with a value of 1.17gcm^{-3}during pre-monsoon season and maximum at control site with a value of 1.99gcm^{-3}during monsoon season. Bulk density of the study site has significant positive correlation with available-P ($r=0.430^{**}$ at $P\leq0.01$) and has negative significant correlation with moisture content ($r=-0.232^{**}$) and organic carbon ($r=-0.295^{**}$at $P\leq0.01$).

Bulk density shows higher value at monsoon season and lowers during post monsoon season which could be due to compaction of soil texture by rainfall. Statistical analysis proved that there was significant change between seasons during the study period ($H=0.001$ at $P<0.05$). Comparing different study sites control sites have higher bulk density value than dumping area. This shows that bulk density was decrease due to waste disposal. Differences in bulk density between dumping site and control sites may be because organic and inorganic materials in the municipal wastes help to increase the soil matrix thereby reducing soil bulk density

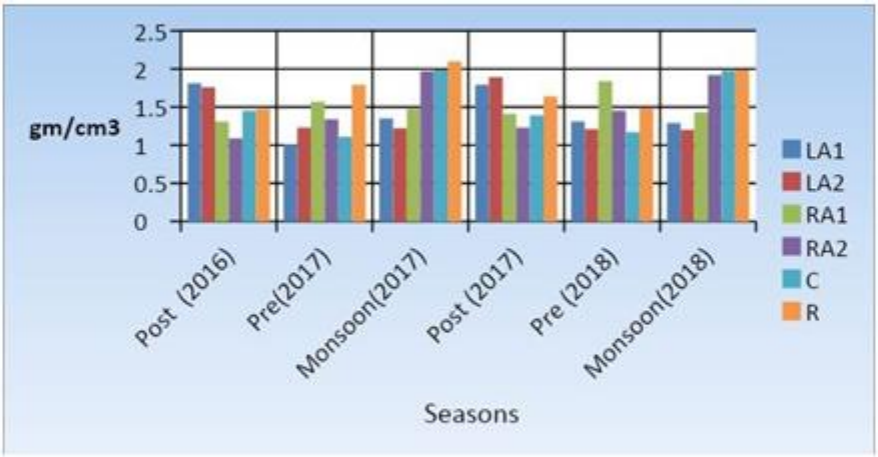

Figure 3.2: Seasonal variation in bulk density (gcm^{-3}) of soil at different sampling sites

Soil Moisture

In the year 2016-2017, moisture content of the soil was found that minimum at control site with a value of 19% during pre-monsoon season and maximum value of 41% at site LA1 during monsoon season. During 2017-2018, moisture content of the soil was found that minimum at control site with a value of 22% during pre-monsoon season and maximum value of 33% at site LA1 during monsoon season. During the study period moisture content has positive significant correlation with total nitrogen ($r=0.397^{**}$at $P\leq0.01$), pH ($r=0.269^{**}$at $P\leq0.01$) and negative significant correlation with organic carbon ($r= -0.192^{*}$at $P\leq0.05$), bulk density ($r=-0.232^{**}$at $P\leq0.01$), and potassium ($r=-0.223^{**}$at $P\leq0.01$).

From the result, it was observed that moisture content of the soil was higher during monsoon period and lower during pre-monsoon period which is due to increase in humidity of soil by rain water. Statistical analysis shows that there was significant change between different seasons ($H=0.00$ at $P\leq0.05$) during the study period. Comparing dumping site and control site, control site has lower moisture content in all seasons this shows that waste has increase the humidity of soil, it is clear from the observation that the waste component of the study site contain majority of organic waste in which leachate result from decaying of waste matter. This is also due to covering up of soil by waste which decreases the rate of evaporation from soil.

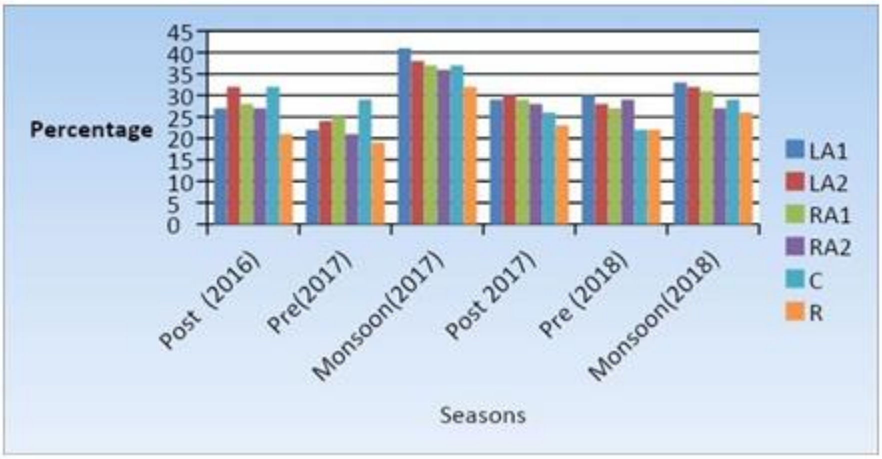

Figure 3.3: Seasonal variation in moisture content (%) of soil at different sampling sites

Organic Carbon

During the year 2016-2017 the minimum organic content was observed at control site with a value of 0.26% during pre-monsoon season and maximum at centre site with a value of 2.32% during monsoon season and in the year 2017-2018 the minimum organic content was observed at control site with a value of 0.25% during pre-monsoon season and maximum at centre site with a value of 1.37% during monsoon season. Organic carbon content of the study site shows positive significant correlation with bulk density ($r=0.190^{*}$ at $P \leq 0.05$) and negative significant correlation with pH ($r=-0.259^{**}$ at $P \leq 0.01$) and moisture content ($r=-0.192^{*}$ at $P \leq 0.05$).

From the observation, carbon content was high during monsoon seasons and lowers during pre-monsoon and post monsoon seasons. This significant change was proved statistically H= 0.023 at $P \leq 0.05$. From the observation it was found that dumping site has higher amount of organic carbon than control site.

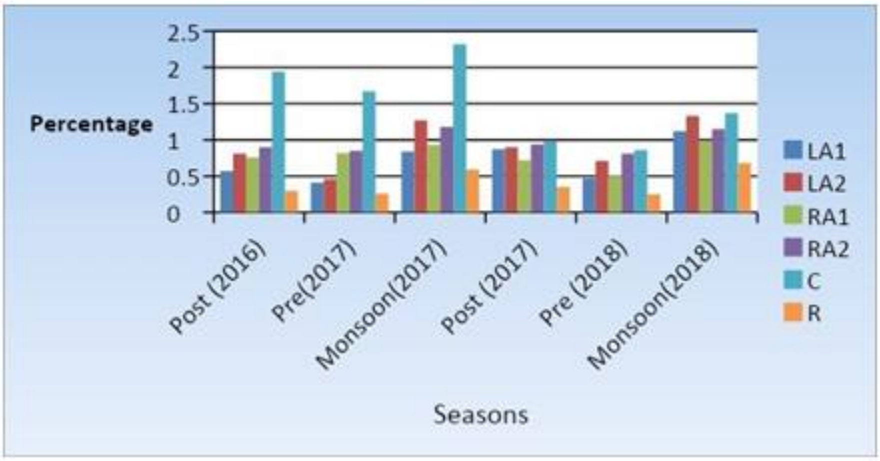

Figure 3.4: Seasonal variation in Soil Organic Carbon (%) at different sampling sites

Total Nitrogen

In 2016-2017, the total nitrogen content was found minimum during pre-monsoon at control site $mgkg^{-1}$ and maximum during monsoon season at centre site 4.41 $mgkg^{-1}$ of the dumping ground. In 2017-2018, the total nitrogen content was found minimum during pre-monsoon at control site 1.08$mgkg^{-1}$ and maximum during monsoon season at centre site 4.43 $mgkg^{-1}$ of the dumping ground. Total nitrogen content of the study site has positive significant correlation with moisture content ($r=0.397^{**}$ at $P \leq 0.01$) and negative significant correlation with bulk density ($r=-0.295^{**}$), available phosphorus ($r=-0.291^{**}$) and potassium ($r=-0.291^{**}$) at $P \leq 0.01$.

From the result, total nitrogen content was found higher during monsoon season and lower during pre-monsoon season this could be due to leachate that enter in the soil through rain water run-off. It has significant change between different seasons at (H=0.00) at $P \leq 0.05$. From the observation it was found that control site has lower nitrogen content than dumping site which could be due to composting of nitrogen containing waste in the soil.

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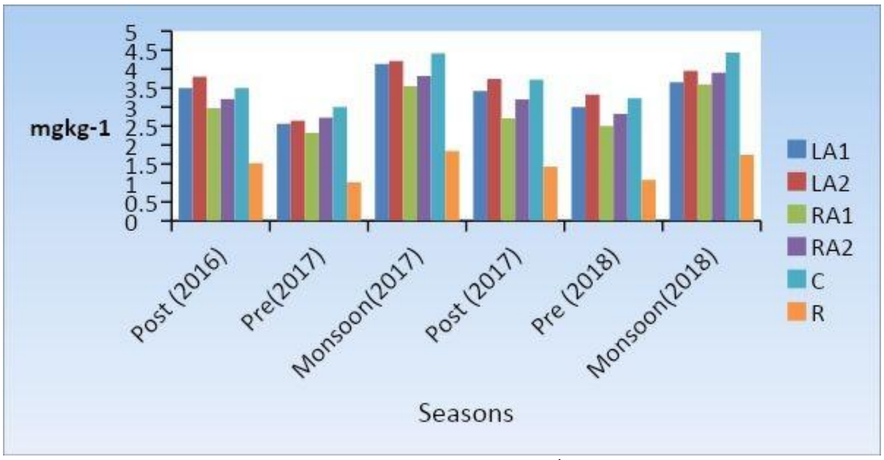

Figure 3.5: Seasonal variation in Total Nitrogen (mgkg^{-1}) of soil at different sampling sites

Available Phosphorus

During 2016-2017, maximum value of available P was observed at centre site of the dumping ground 4.82mgkg^{-1} during monsoon season and minimum at control site 0.32mgkg^{-1} during pre-monsoon season. During 2017-2018, maximum value of available P was observed at centre site of the dumping ground 4.32mgkg^{-1} during monsoon season and minimum at control site 0.3mgkg^{-1} during pre-monsoon season. Throughout the study period it has positive significant correlation with pH (r=0.334**) and bulk density (r=0.430**at P≤0.01), negative significant correlation with Total Nitrogen (r=-0.291**at P≤0.01).

From the observation, the value of available P was found to be higher during monsoon season and lower during pre-monsoon season. There was seasonal variation at P≤0.05 (H=0.00) in the study site. From the observation it was found that dumping site has higher available-P than control site. This could be due to composting of leachate containing phosphorus elements especially from domestic waste.

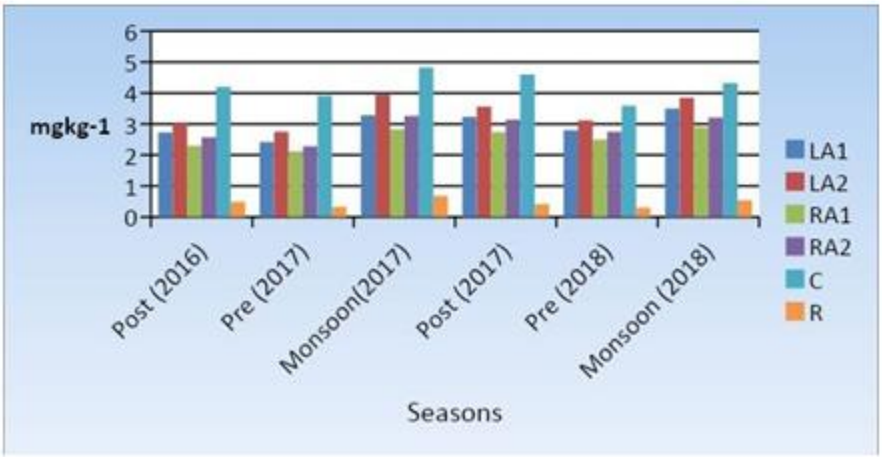

Figure 3.6: Seasonal variation in available P (mgkg^{-1}) of soil at different sampling sites

Exchangeable Potassium

During 2016-2017 maximum value of exchangeable K was observed at centre site 405.78mgkg^{-1} in monsoon season and minimum at control site 90.36mgkg^{-1}during post monsoon season. In 2017-2018 maximum value was found at centre site 405.69mgkg^{-1} during monsoon season and minimum at control site 103.27mgkg^{-1} during pre-monsoon season. During the study period it has negative significant correlation with pH (r=-0.208*at P≤0.05), moisture content (r=0-.223**) and total nitrogen (r=0-.274** at P≤0.01).

From the observation it was found that exchangeable P was lower during pre-monsoon and post monsoon season and higher during monsoon season. Significant change was observed between different season (H=0.00) at P≤0.05 during the study period. This could be due to increase in rate of decomposition by rain water which increase humidity and leachate can easily enter to soil from run-off.

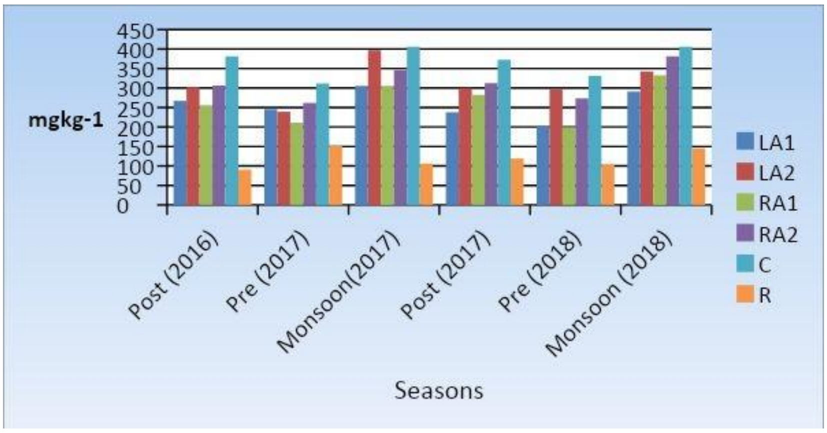

Figure 3.7: Seasonal variation in Exchangeable K of soil at different sampling sites

4. Conclusion

From the study, it is observed that physico-chemical properties of soil collected from six different sites depends upon seasonal change. All the data were also analysed statistically to check the seasonal variation by one way ANOVA test. From the observation, it is clear that the physico-chemical properties of the soil under Kolasib Town are significantly differing from season to season. By the alteration in rainfall and temperature regimes, a physico-chemical property of soil varies significantly. In the high precipitation region like Mizoram, climate directly affects the rate of weathering which further results in the change of soil properties.

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