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Variation of soil nutrients of *Aesculus indica* at different altitudes of Kashmir

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Abstract
Soil is one of the most important factor for the survival of plants since they get water supply and nutrients besides their dependency anchorage. Not only has this, plants in turn indirectly affected their neighbors in many ways one of the most important by altering the biotic, physical and chemical characteristics of soils. The altitudinal gradient of mountain is characterized by variable temperature and different precipitation records. Fertility of soil is determined by the presence or absence of nutrients which have agronomic importance. Kashmir a temperate Himalayan region were *Aesculus indica* grows at different altitudes and is depleting at an alarming rate. Variations' were observed at higher and lower altitudes of soil nutrients of *Aesculus indica* in the present study. Lower altitudes have more soil nutrients as compared to the higher altitudes in all the study sites. . Generally cooler, wetter condition at higher altitude reduces biological activity and increase leaching. Steeper profile encourage run off and subsurface movement of water down slope. This manifests in the reduction of nutrients susceptible to weathering such as potassium (K). Associated with the loss of alkaline metal ion like (K+) from the soil is a decrease in soil pH. This is the reason behind pH significant decrease with increasing altitude.

Keywords: Soil, nutrient, altitude, Aesculus, indica

Introduction
The term soil is usually defined as a complex mixture of eroded rock, mineral nutrients' decaying organic matter, water, air, and billions of living organisms, most of them are microscopic decomposers (G.T. Miller 2007) [12] Soil contains 13 out of 16 different elements essential for plant growth (Raven *et al* 1995) [22]. The altitudinal gradient of mountain is characterized by variable temperature and different precipitation records. Variable temperature and moisture differences generated from elevation and aspect gradients may have the same effect on organic matter decomposition (Griffiths *et al* 2009) [7]. Soil is one of the most important factor for the survival of plants since they get water supply and nutrients besides their dependency anchorage. Not only has this, plants in turn indirectly affected their neighbors in many ways one of the most important by altering the biotic, physical and chemical characteristics of soils (Eaton et al 2004) [4]. Climate, another most dominant ecological factor acting over parent material for a never ending large period of time is responsible successive changes in soil development. Many morphological, physical, chemical, biochemical and macro and microbiological reactions and processes occur simultaneously and also interactively in soils which not only affect the soils own character slowly and steadily but also influences the immediate environment and the plants it supports and nourishes (Verma *et al* 2008) [30]. The reaction and processes which affect the soils character and their properties are in turn influenced by several natural factors viz., climate, organism, parent material and modified to a great extent by the relief features such as slope and altitude (Verma *et al* 2008) [30]. Soil fertility is important factor which determines the growth of the plant. Soil fertility is determined by the presence or absence of nutrients i.e., macro and micronutrients (Nazif *et al* 2006) [18]. Macronutrients such as nitrogen, phosphorous and potassium together make up trio known as NPK. All these nutrients are accumulated by the plants in their bodies in different concentrations. However these nutrients are usually lacking from the soil because plants use them in large amounts for growth and survival. Hence these nutrients are known to govern the fertility of soils, control the yields of crops (Kumar *et al* 2011) [8] and hence have agronomic importance. In general soils constitute a bank of majority of nutrients essential for plant growth i.e., plants grow by absorbing nutrients from the soil. Their ability to do so depends on the nature of soil.

The various components of soil include mineral matter soil organic matter and humus, soil water / soil solution, soil atmosphere and biological system. Soil organic matter has long been recognized as an important indicator of soil productivity. It refers to the organic fraction of the soil exclusive of undecayed plant and animal residues and plays a crucial role in maintaining sustainability for cropping systems by improving soil physical (texture, structure, bulk density and water holding capacity), chemical (Nutrient availability, cation exchange, reduced aluminium toxicity allelopathy) and biological (nitrogen mineralization bacteria, dinitrogen fixation, mycorrhizae fungi and microbial biomass) properties (Fageria 2012) [5]. Soil organic matter is known to adsorb heavy metals from the soils and hence can reduce toxicity of these metals to plants and also reduce their escape to the ground. Over the past decades, high altitude soils have attracted more attention in the debate on the potential impact of environmental changes on the global carbon cycle (Li and Zhou, 1998; Oechel et al., 2000) [9, 19]. The Kashmir Himalaya being nestled within north-western folds of Himalaya, harbours a rich floristic diversity of immense scientific interest enormous economic potential (Dar and Khuroo 2013) [13]. The aim of the present study was to estimate the various soil properties such as PH, organic carbon, available nitrogen, phosphorous and potassium of the soil samples of *Aesculus indica* and to assess the effect altitude in these properties.

Materials and Methods

The present study was carried out in different areas of Kashmir Himalaya.

The organic carbon content of soil samples were estimated by colorimetric methods**.** The oxidation of soil organic matter was carried out by dichromate- sulpuric acid mixture. The intensity of green colour of cromium sulphate formed was measured to give directly the amount of corbon dioxide.1 gm of soil sample was inoculated in 100 ml conical flask and added 10 ml of 1N $K_2Cr_2O_7$ and 20 ml of concentrated H_2SO_4 followed by shaking. After 30 minutes it centrifuges at 8000 rpm for 5 Minutes, Supernatant was collected and measured the intensity of green colour at 660nu. The available nitrogen of soil samples were estimated by the method described by and weight of the soil is mixed with excess of alkaline KMnO4 solution and distilled. The organic matter present in the soil is oxidized by the nascent oxygen, liberated by $KMnO_4$ in the presence of NaOH and the released ammonia is condensed and absorbed in a known volume of a standard acid the excess of which is titrated with a standard alkali, using methyl red as an indicator. 20g of soil was transferred to 800 ml Kjeldal flask and 20 ml of water and 100 ml of 0.32% KMnO4 solution were added. To prevent frothing and bumping during distillation, 1 ml of liquid paraffin and a few glass beads or broken pieces of glass rod were added to the flask. 20 ml of N/50 H_2SO_4 was pipetted in a conical flask and 2-3 drops of methyl red indicator was added and mixed end of the delivery tube was dipped into it. Simultaneously, tap water was run in the condenser. After that 100ml of 2.5% NaOH Solution was added into the flask and corked immediately and heater was switched on. After heating, evolution of ammonia gas from the distillation flask was absorbed in standard H_2SO_4 solution (test by bringing a moist red litmus paper near the outlet of the condenser, which will turn blue as long as ammonia is being evolved) and approximately 40ml distillate was collected. After the completion of distillation, the conical flask containing distillate was firstly removed and the heater was switched off to avoid back sucking. Excess of H_2SO_4 was titrated against N/50NaOH and volume of NaOH used was noted. The end-point reached when the color changed from pink to yellow. The available phosphorus of soil samples were estimated by olsen's method (Olsen, 1954) [20]. The soil is extracted with 0.5M $NaHCO_3$ pH 8.5 in the presence of Darco G-60 (Which adsorbs dispersed organic matter and help in giving clear extract). Phophorus in the extract is treated with ammonium molybdate, which results in the formation of heteropoly complexes (Phosphomolybdate). The phosphomolybdate is reduced by the use of $Sncl_2$ (a reducing agent). Due to this reduction, some of MO^{6+} is converted to Mo^{3+} and/or Mo^{5+} and the complex assumes the blue color. The intensity of blue color obtained can be measured at an appropriate wavelength on a visible spectrophotometer. In calcareous, alkaline or neutral soils, $NaHCO_3$ buffered to pH of 8.5 controls the ionic activity of Ca Through precipitation of Ca as $CaCO_3$, As a result, the concentration of H_2PO4 in solution increases. In acid soils, Al and Fe phosphates (the H_2PO_4) concentration in the solution increase as pH rises by way of suppressing Al and Fe activities by adding NH_4F. Again the secondary precipitation reaction is kept at minimum because the concentration of Al, Ca and Fe remains at a low level in the extractant. 2gm of soil was transferred to a 100 ml wide mouth glass bottle and a pinch of Darco G- 60 and 25 ml of 0.5 M $NaHCO_3$ solution was added. The suspension was shacked for 30 minute on mechanical shaker and filtered through what man No.1 filter paper to obtain the filtrate 5 ml of the filtrate was transferred to a 25 ml; volumetric flask, with 5 ml of ammonium molybdate solution. The solution was shacked slowly to drive out the CO_2 evolved. When frothing ceased completely, distilled water was added in such a manner that it washes down the sides, to bring the volume to about 15 ml. Later 1 ml of freshly diluted Sncl2 Solution was added. The volume was made up with distilled water to 20 ml and mixed, blue color intensity was read at a wavelength of 660nm using a red filter on spectrophotometer. The method was based on the principle of equilibrium of soils with an exchange cation made of the neutral normal NH_4OAC in a given soil: solution ratio. During an equilibrium, ammonium ion exchange with exchangeable K ion of the soil. The K content in the equilibrium solution is estimated with a flame photometer. 5g soil was transferred to a 100ml conical flask and 25ml of neutral NH_4OAC solution was added and shacked for 5 minutes and filtered through What man No.1 filter paper. K concentration was measured in the filtrate using flame photometer.

pH: 20g of soil samples were added in to 100ml of distilled water for making soil-water suspension, after 30 min electrode of pH meter (EKICO-251) was used for observations.

Results and Discussion

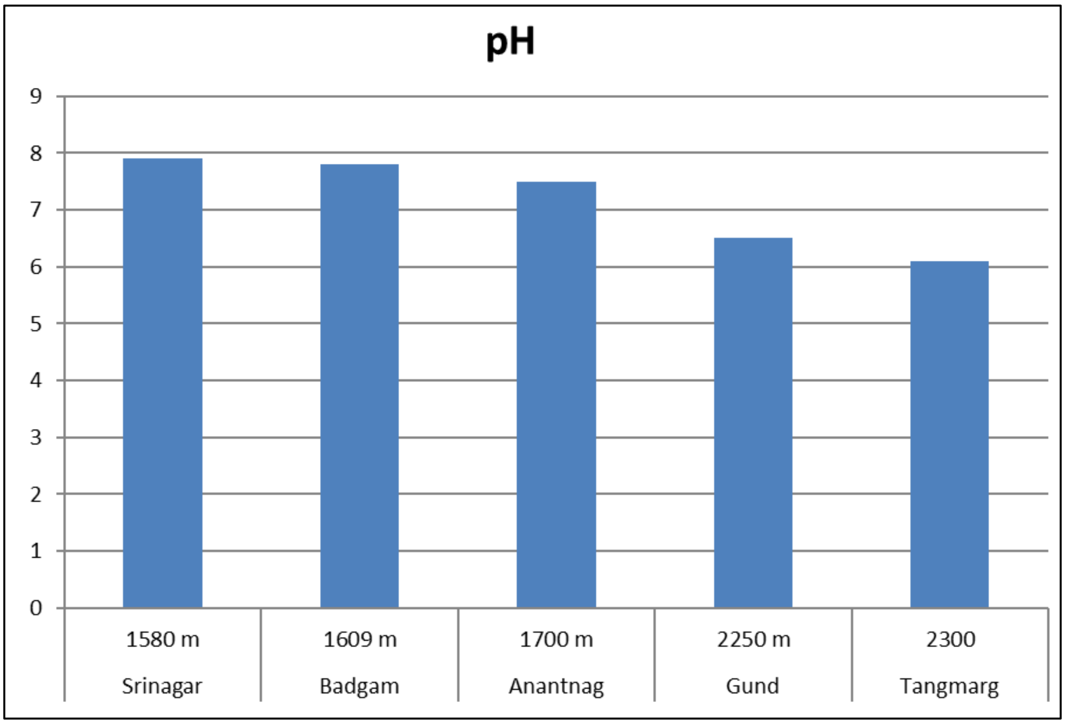

Fig 1: Variation of soil pH of *Aesculus indica* at different altitudes of Kashmir

The data from the above graph showed that there is variation of pH at different altitude. Highest pH (7.9) was recorded at Srinagar followed by Budgam with (7.8), Anantnag (7.5), Gund (6.5) and least Ph was recorded at Tangmarg with (6.1). The data clearly indicates that Ph of low land and high land *Aesculus indica* plant soil samples shows variation. This means that low altitudes are slightly alkaline to neutral while higher altitudes slightly acidic. Generally cooler, wetter condition at higher altitude reduces biological activity and increase leaching. Steeper profile encourage run off and subsurface movement of water down slope. This manifests in the reduction of nutrients susceptible to weathering such as potassium (K). Associated with the loss of alkaline metal ion like (K+) from the soil is a decrease in soil pH. This is the reason behind pH significant decrease with increasing altitude (Schawe *et al*., 2007; Proctor *et al.,* 2007; Wilcke *et al.,* 2008) [24, 21, 31] as seen in the current study figure 1. These alkaline metal ions are deposited in the lower altitude causing an increase in pH around these areas. Low soil pH in the higher altitude is also thought to reflect the acidic nature of organic matter decomposition (Schrumpf *et al.,* 2001) [25]. High land soils had low pH (Acidic nature) probably because of leaching of bases due to higher rainfall besides release of Organic acids by slight decomposition of organic matter, where as lower altitude *Aesculus indica* soils are alkaline to neutral because of their calcareous nature. Similar findings were also recorded by Verma *et.al* (2008) [30], (Mohana-Rao 1977) [15], Minhas and Bora (1982) [13], Mandal *et al* (1990) [11] and Murthy and Sharma (1992) [16]

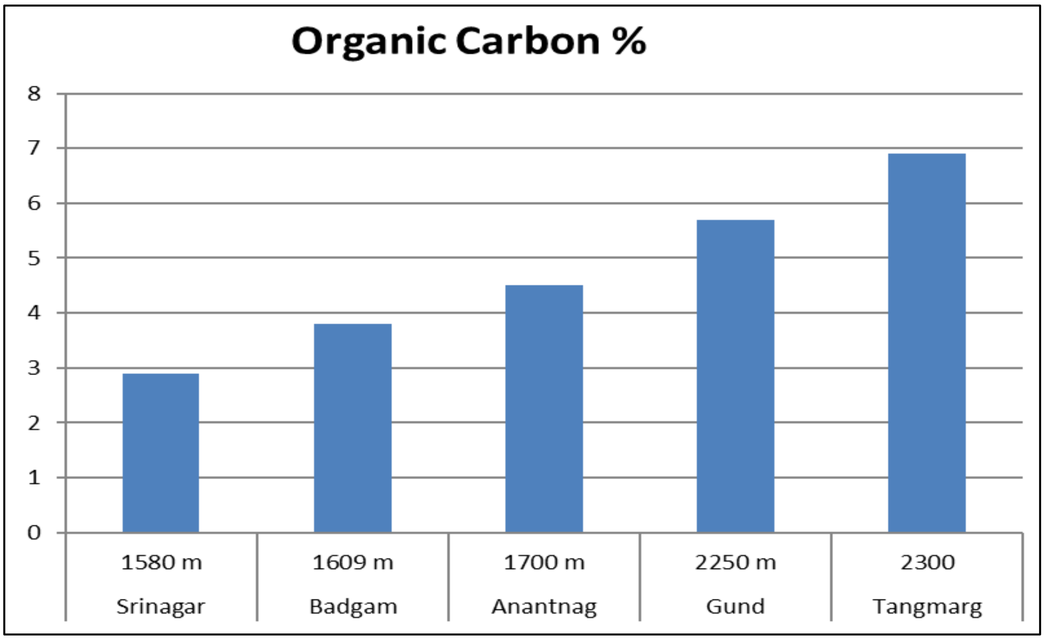

Fig 2: Variation of soil Organic Carbon at different altitudes of Kashmir

Soil Organic Carbon has long been recognized as an important indicator of soil productivity. It refers to the organic fraction of the soil exclusive of undecayed plant and animal residues and plays crucial role in maintaining sustainability of cropping systems by improving soil physical (texture, structure, bulk density and water-holding capacity), Chemical (nutrient availability, Cation exchange capacity reduced aluminium toxicity and allelopathy) and biological (nitrogen mineralization bacteria, dinitrogen fixation, mycorrhizae fungi and microbial biomass) properties. Soil Organic matter is known to adsorb heavy metals from the soils and hence can reduce toxicity of these metals to plants and also reduce their escape to ground water. Organic Carbon varied from 2.9% to 6.9% from low and high altitudes. Highest Organic Carbon percentage was recorded at Tangmarg with (6.9%) followed by Ganderbal with (5.7%), Anantnag with (4.5%) and lowest organic carbon was recorded in the soils of Srinagar with (2.9%). Organic Carbon content of the soils showed an increasing trend from low land soils, medium land soils to high land soils. Comparatively more organic carbon content was recorded in high altitude soils probably due to accumulation of higher amounts of organic matter because of wet conductions which favour luxurious plant growth and low temperature that decreases rate of Organic matter decomposition. Low Organic Carbon content of low and medium land soils was probably because of high temperature and good aeration which are responsible for the increased rate of oxidation of organic matter. These results are in accordance with Verma *et al* (1990) [29] according to him more Organic Carbon content is in high altitude soils then in low altitude soils. Mandal *et al* (1990) [11], Minhas *et al* (1997) [14], Malik *et al* (2000) [10], and Najar *et al* (2006) [17], also showed that high altitude soils have more organic carbon content then in low altitude soils. Singh and Mishra (2012) [26] reported that low organic carbon content of low and medium land soils was probably because of high temperature and good aeration.

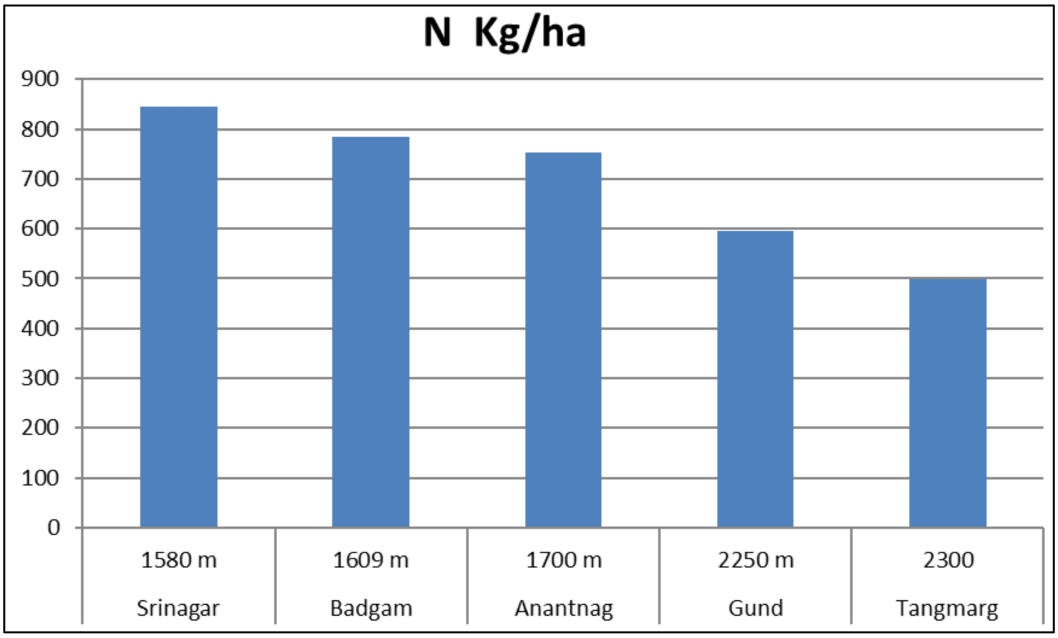

Fig 3: Variation of soil Nitrogen at different altitudes of Kashmir

The availability of nitrogen is not only an essential part of carbohydrates, fats and oils but also an essential ingredient of proteins. The available nitrogen is an important factor to increase the soil fertility. In terms of its requirement and management in the field, nitrogen is the most important nutrient for all crop plants. The availability of nitrogen is closely associated with plant productivity. Nitrogen is used by plants in two forms, ammonium and nitrate. Nitrate is the dominate form of mineral nitrogen available for plant use. The sum of the two forms constitutes the pool of plant-available nitrogen. Available Nitrogen ranged from 846 Kg ha⁻ to 498 Kg ha⁻ from higher and lower altitudes respectively. Highest nitrogen content was recorded at Srinagar with 846 Kg ha⁻ followed by Budgam with 784 Kg ha, Anantnag 752 Kg ha⁻ and lest nitrogen content was recorded in the soils of Gund with 596 Kg ha⁻ and Tangmarg with 498 Kg ha⁻. This is because in low land areas there is comparatively high temperature that triggers higher mineralization rates of organic nitrogen releasing more available nitrogen. This is in accordance With the studies reviewed by Tanner *et al.* (1998) [28].

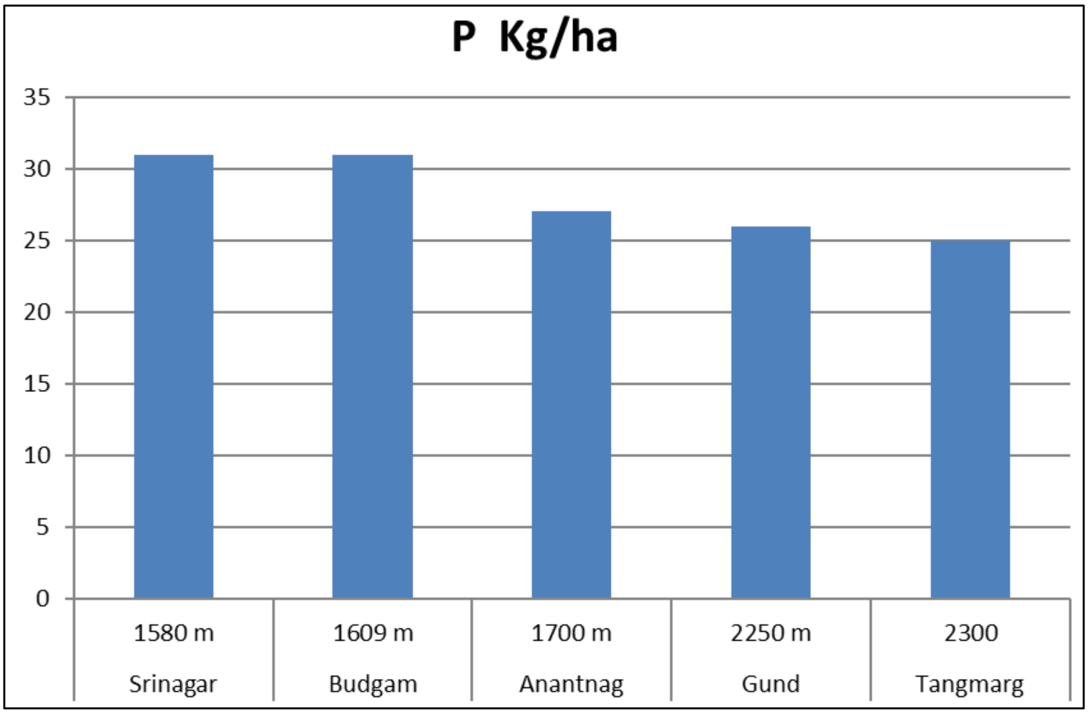

Fig 4: Variation of soil phosphorus at different altitudes of Kashmir

With increasing demand of agricultural production and as the peak in global production will occur in the next decades, phosphorus (P) is receiving more attention as a nonrenewable resource (Cordell et al., 2009;) [2]. One unique characteristic of P is its low availability due to slow diffusion and high fixation in soils. All of this means that P can be a major limiting factor for plant growth Furthermore, P uptake and utilization by plants plays a vital role in the determination of final crop yield. A holistic understanding of P dynamics from soil to plant is necessary for optimizing P management and improving P-use efficiency, aiming at reducing consumption of chemical P fertilizer, maximizing exploitation of the biological potential of root/rhizosphere processes for efficient mobilization, and acquisition of soil P by plants as well as recycling P from manure and waste. Taken together, overall P dynamics in the soil plant system is a function of the integrative effects of P transformation, availability, and utilization caused by soil, rhizosphere, and plant processes. This Update focuses on the dynamic processes determining P availability in the soil and in the rhizosphere, P mobilization, uptake, and utilization by plants. It highlights recent advances in the understanding of the P dynamics in the soil rhizosphere-plant continuum. Plants are able to respond to P starvation by changing their root architecture, including root morphology, topology, and distribution patterns. Increases in root/ shoot ratio, root branching, root elongation, root topsoil foraging, and root hairs are commonly observed in P-deficient plants, while the formation of specialized roots such as cluster roots occurs in a limited number of species.

Available phosphorous ranged from 26 Kg ha⁻ to 31 Kg ha⁻ from higher and lower altitudes respectively. Highest phosphorous content was recorded at Srinagar and budgam with 31 Kg ha⁻ followed by Anantnag with 27 Kg ha⁻, Gund with 26 Kg ha⁻ and lest phosphorous content was recorded in the soils of Tangmarg with 25 Kg ha⁻. The high level of available phosphorous reported in the soils of lower altitudes was perhaps due to the calcareous nature of these soils. Moreover, the biggest reserves of phosphorous in soils are considered to the rocks and other deposits, such as primary minerals including Apitate, Hydroxyapitate and Oxyapitate. Another reason for this could be the regular applications of phosphorous fertilizers. Similar results were also reported by (Richardson 1994) [23]. Changes in soil properties with altitude is influenced strongly by microclimate and topography (Proctor et al., 2007; Bendix *et al.*, 2008; Wilcke *et al.*, 2008; Gerold *et al.*, 2008) [21, 1, 31, 6]. Generally cooler, wetter condition at higher altitude reduces biological activity and increase leaching. Steeper profile encourage run off and subsurface movement of water down slope.

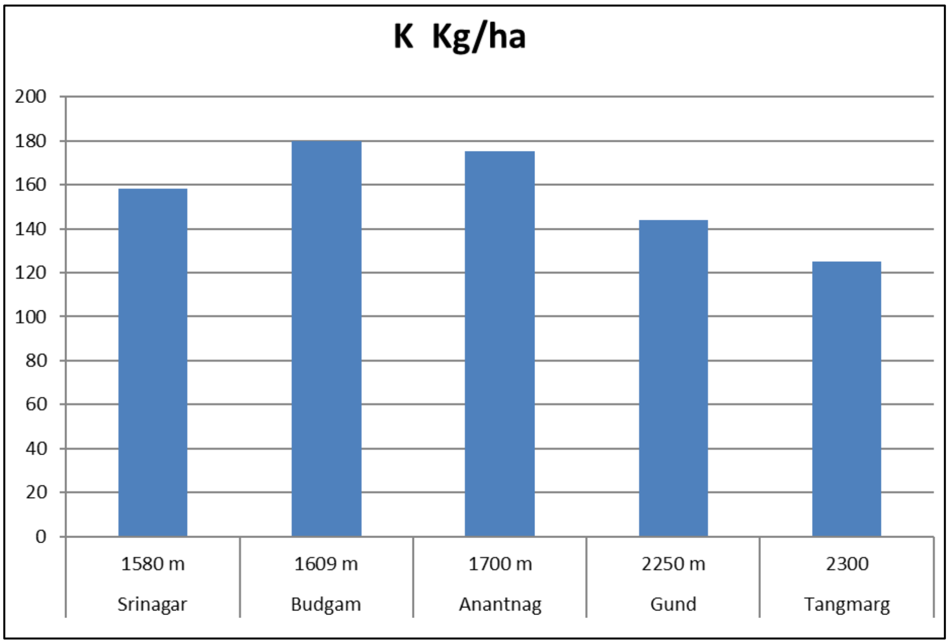

Fig 5: Variation of soil potassium at different altitudes of Kashmir

Potassium is an essential macronutrient for plant growth and development as well as for many plant functions. Testing potassium availability in soil plays the major role in estimating fertilization requirements. Potassium has four soil forms: solution, exchangeable, non-exchan-geable, and mineral. The water soluble and exchangeable forms represent the available fraction of potassium. Where as non exchangeable and mineral potassium forms are known to be slowly available. Unavailable Potassium availability is a complex situation; depletion of one form shifts the equilibrium between forms to replenish it (*i.e.* Non-Exchangeable K ↔ Exchangeable K ↔ Soil Solution). Potassium uptake by plants is governed by the rate of transport from the bulk soil to the root via diffusion. It is expedient to measure a parameter that is closely related to diffusion. This might be achieved by measuring the concentration of soil potassium in the solution and exchangeable forms. During the present study highest potassium content was recorded at budgam with (180 ppm) Kg/ha followed by Anantnag with (175 ppm) Kg/ha, Srinagar with (158 ppm) Kg/ha and lowest potassium content was recorded at Gund and Tangmarg with (138 ppm) Kg/ha and (125 ppm) Kg/ha respectively. In general soils of lower altitudes have higher content of potassium while as the soils of higher altitudes have lower content of potassium. These results are in accordance with the (Proctor et al., 2007; Bendix et al., 2008; Wilcke et al., 2008; Gerold et al., 2008) [1, 31, 21, 6]. Generally cooler, wetter condition at higher altitude reduces biological activity and increase leaching. Steeper profile encourage run off and subsurface movement of water down slope. This manifests in the reduction of nutrients susceptible to weathering such as potassium (K). Associated with the loss of alkaline metal ion like (K+) from the soil is a decrease in soil pH.

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