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Forest Engineering - An Earthquake Damage Repair Device

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Abstract

In order to overcome the earthquake disaster of Nepal an attempt could be made with attention focused on vegetation, realizing the damage done over the concerned trees which are the support and supplier of logs and timbers for building materials, bridges, roadways, shelters and to some extent food, barks, resin products, secondary metabolites with enormous medicinal properties and of economic values. As Nepal is rich in tall gymnosperm us species including conifers like Pinus sp, Picea sp, Tusga sp, Larix sp, Abies sp, Juniperus sp and angiosperms like Sal (Shorea Robusta), Semal (Bombax malabricum), Asna (Terminalia termentosa), Dalbergia spp, pipal (Ficus religiosa), banyan (Ficus bengalensis), Castenopsis indica, Schima wallichii, Alnus nepalensis, Acer oblongum and various species of bamboo, oak, rhododendron moreover Orchids and climbers were greatly affected besides natural shrubs and herbs. But they try to avoid and escape such damage through morphological, anatomical, biochemical, genetical alterations as plants are the immovable properties of nature. A preamble prediction could be done to understand the magnitude of damage due to the Shearing (S) and Primary (P) waves as plants experience such waves those disturb the sub-aerial root system which in turn badly impaired the biology of the plants as a whole including water conduction, cell signaling, loss of neighbour detection and other major threats that results the loss of biodiversity. So, much attention is to be paid on forest development and its resurrection-Forest Engineering.

Keywords: Earthquake, Biodiversity, Gymnosperms, Angiosperms, Orchids, Forest Engineering.

Introduction

A process that began millions of years ago, it was when India separated from Australia followed by Madagascar, and began to drift into the Eurasian plate perpetuated by the circulating currents in the liquid mantle during Jurassic Age and pushed against the strip of land in between and started to fold the land thus forming the largest folded range on earth, i.e., the Himalaya[1]. Due to slow but continuous movement of two gigantic land masses enormous tension generated along the 2,400 km boundary between the plates, however, only less than half of the Himalayan arc has been ruptured in the last few decades thus unbroken segments raises concern about impending great earthquakes as per geophysical researches. The earthquake in Nepal on 25th April, 2015 affected only 150 km into the zone leaving more than 400 km of the gap, encompassing parts of Nepal and northern India viz. Uttarakhand, Himachal Pradesh and western Bihar stressed and vulnerable to earthquake disaster.

From bacteria to plants and from protozoa to animals no one can get rid of the devastation of earthquake. The major threat of which starts with habitat trouncing that encompasses other threats and damages in different level of biological spheres. Recently what Nepal has experienced on 25th April 2015 is not only a 'Millennium' Curse but also a hammer on the mankind; loss of population, livestock, vegetation, flora, fauna, natural and biodiversity resources. Environmental disturbances are serious concern of this natural disaster. Rebuilt, re-procurement, repair, rehabilitation and renovation are only the terms and steps come as emergent issues here; but where and how to start is a great question particularly where the post-aftershock effects persist. An attempt could be made to open the chapter with biological keys involving the vegetation particularly realizing the damage done by the earthquake over the concerned trees which are the support and supplier of logs and timbers for building materials, bridges, roadways, shelters and to some extent food, barks, resin products, secondary metabolites which having enormous medicinal properties. Immovable properties of nature klendusically raised tall gymnospermous species including conifers from pineceae *Pinus roxburghii, Picea sp, Tusga sp, Larix sp, Abies sp, Juniperus sp* and angiosperms like Semal (*Bombax malabricum*), Sal (*Shorea Robusta*), Asna (*Terminalia termentosa*), *Dalbergia sp*, pipal (*Ficus religiosa*), banyan (*Ficus bengalensis*), chinquapin (*Castenopsis indica*), *Schima wallichii*, Nepalese alder or Utis (*Alnus nepalensis*), Himalayan Maple (*Acer oblongum*) and various species of bamboo, oak and rhododendron which cover the higher slopes and moreover Orchids and climbers grown on the stems of trees greatly affected besides natural shrubs and herbs whatever may be the natural threats and disaster lashed upon them but try to avoid and escape through morphological, anatomical,

biochemical, genetical alterations. A brief preamble prediction and instantaneous survey on grim vegetation could be done to understand the magnitude of damage both horizontal and vertical level due to the Shearing (S) wave and Primary (P) wave in randomized eco-operational research. Mainly the plant root system experiences both horizontal and vertical waves which disturbs the sub-aerial part firstly involving its morpho-physiological, anatomical, biochemical, genetical then transmitting the signal to the aerial shoot. The shoot-root and trunk-branch system disconnection and deformation, leaf fall, loss of propagating stocks and seeds, internal physiological damage particularly in water conduction and cell to cell signal transmission, loss of neighbour detection and other major threats eventually results the loss of biodiversity at a great stake. So, much attention is to be paid on forest development and resurrection.

Morpho-Anatomical changes

Plants being sessile exposed to environmental stress along with injuries, managed to survive with loss of nutrients and microbial attack. Thus plants develope specialize morpho-anatomical and physiological mechanisms to act in response to stress or wounding. Cambium the tissue 'rejuvenator' and 'builder' is the stakeholder in plant defense after any kind of injury through which necrosis and hypertrophy may be started. After scanning the wounds the injured tissue starts to develop callusing[2]. Conifers upon injury produce tangential rows of traumatic resin ducts (TRD) which extend both tangentially and axially in the developing secondary xylem e.g., *Larix sp, Picea sp*., *Abies sp*.[3,4]. Depending on the impact of damage the trees form secondary mechanical tissues for strengthening the trunk[5].

Debris flows, flash-floods or landslides are common after an earthquake causing decapitation of trees with reduced growth and disruption or limitation of water and nutrients[6], breaking of branches and occasionally burial of trees occur. Seldom, adventitious roots produced from buried parts close to the new ground surface. The tremor weaves result breakage of shoot crown coined as the "hula-hoop" effect[7,8] and finally subsidiary lateral branches take position around the broken crown for SOS[9, 10].

During mass-movement or enduring destabilization process or even due to horizontal and vertical waves during earthquake abrupt pressure changes may cause the stem[11, 12] being uprooted along with destruction of roots. As the tilted trees try to revive some eccentrically growth rings generated as secondary mechanical support with stunted growth. In case of conifers compression wood frequently produced on the underside of the trunk[13] as compared to the upslope side where individual rings of early- and latewood tracheid cells having thick and rounded cell walls considerably larger and slightly darker in appearance. In contrast, broadleaved trees upon tilting form tension wood[13, 14] formed eccentrically.

The magnitude of weave shock exert its deleterious effect on various tissues according to their tensibility, stress, mechanical armor, elasticity of vascular tissues so from epidermis to medulla the lignified tissues show much resistance than the cortical parenchyma[15] causing severe anatomical changes in individual growth rings similar to those in the stem or branches[16, 17]. Geomorphic processes left sporadically the damaged and truncated trees in an unaffected population of their neighbors to distinguish their neighbors themselves by phytochrome B mediated signaling biology[18].

Genetically and Biochemical changes

Wound healing of earthquake staggered vegetation is a natural process. It is characterized by its slow recovery phase, tissue rejuvenating phase, rapid signal transduction phase, rapid water and mineral translocation phase suppliments and supply nascent amino acids, secondary metabolites, gummy and waxy substances followed by rapid drying up of the open cuts are the series of eventual physio-chemical changes could be taken into account.

The pseudo-dynamic structure of cell wall offer protection against wound spreading of wound, a predisposing factor of pathogen attack[19]. In this regard, first line of defense in plants are cuticle, composed of cutin and epicuticular waxes[20, 21] and sensing the loss of integrity of cuticle followed by cell wall and plasmamembrane is a key event during stress or injury[22, 23]. Usually receptors like different kinases (RLKs) and lectins are assumed to be the sensor[24,25] which then generates ROS followed by lignin[26]. The status of pectin also contributes to the sensing of cell wall integrity alterations[27] and oligogalacturonides (OGs) are possible indicator of altered pectin integrity[28]. Wound-induced molecular responses are rapid and signaled by outer cell wall-derived oligogalacturonides (OGs) and peptides like systemin[29] thus occurs the oxidative burst and expression of defense-related genes leading to callose deposition, gummification of resinous materials, accumulation of protein and hydrolytic enzymes i.e., chitinases and gluganases, leaching of tissue reserves enriched with eassantial bio-organo materials like amino acids (prolein, cysteine, methinine), sugars, salicylic acid, phenols, terpenoids and other heterocyclic compounds. The peptide systemin, oligogalacturonides, oligosaccharides from the pectic component of the cell wall involves in response to wound cure.

Responses to wounding are of two types viz. local response (at the site of damage) and systemic response (occurs systemically) that mediated by hormones like jasmonic acid, ethylene, salicylic acid, and abscisic acid. Concerned genetical support is rapidly encouraged and overexpressed in such stressful condition which commonly expressed oxidative, dehydration and heat-shock proteins, etc[30,31]. Strigolactone a recent considered phytohormone has immense role in plant defense and/or in phytoparasitism opens a new chapter of earthquake damaged vegetation for sustainable survivality. Current studies

have shown that SLs might be factors that influence the plant to respond to deficiency of macronutrients mainly Phosphorus (P). Although, SLs dependent modulation of root is in connection with cross-talk of other hormones, such as auxin and strigolactone effect could be positive or negative depending on auxin concentration[32]. Surprisingly, induction of 'pin' (auxin trafficking - pin protein) a Multi Drug Resistance (MDR) protein related to auxin flow facilitating the wound healing which also induced by electrical pulses[33] or hydraulic waves[34]. Moreover, OGs also provoke auxin responses[35,36]. In this regard, a lectin receptor kinase-I.9, having sensitivity towards extracellular ATP involved in the wound responses[37]. Expression of wound signaled jasmonic acid biosynthesis, Calcium bound signal receptor proteins have significant role. Spectra wide protection is ultimately bestowed upon the interplay of high protein accumulation especially aquaporins, lipid trafficking, ABC transporters in a highly vigorous biochemical drive[38].

Conclusion

Out of many natural calamities by which the environment has being struck from time to time earthquake is the most dreadful one because of its unpredictable, unforecasted and undefined whip over the livestocks including mankind. The 7.8 Richter earthquake that struck Nepal on 25th April 2015 was just one of a series of consequences that have shaken the region ever since its origin. The annihilation of thousands of lives in Nepal is a reminder of how precarious our existence is on this ever-shifting planet which is further more worsens for forest trees. Thus as a part of disaster damage management it requires repair and rehabilitation of earthquake affected vegetation that initiated with the critical and methodical survey of depth and magnitude of damage both horizontally (area of vegetation) and vertically (individual damage) where survibility is at stake with damage level at 100%, 80%, 75%, 50%, 25% respectively, could be measured with the help of specific modernized instrumentation and molecular tools. The eco-operational research could be implemented by developing local camps and field laboratories for rapid survey. In this regard radio-imaging of wood by hard and soft X-ray with prior Beryllium administration for both hard and soft tissues.

Simultaneously different Spectroscopic analyses like Infra-Red, Near Infra-Red, Raman Spectroscopy with potentially advanced scanner to detect in situ surface deformation or deterioration. By analyzing solids, semi-solids or any secretion that come out from injuries, microscopy or tomography of sample also help a much to evaluate the nature of damage. The earthquake of such a magnitude is very less frequent environmental stress but put huge impediments over the biological organisms unlike the other calamities. So, very careful and meticulous study could be conducted for developing Earthquake Damage Response Database (EDRD).

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