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Climate Change: Agriculture and Mycorrhiza

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Abstract- Climate change is the global phenomenon of climate transformation characterized by the changes in the usual climate of the planet that are especially caused by human activities. It is the difference in the Earth's global climate or in regional climates over time. Shifting of seasons, increasing global temperatures rising sea levels, changing agricultural patterns have resulted in frequent disasters like landslides, tsunamis, drought, famine, population migration and major health hazards not just for us but also our children and grandchildren. Climate change has already increased the volatility of prices of agricultural commodities. Human induced transformation of Earth's ecosystem has strongly affected distribution patterns of plant - fungus symbiosis known as mycorrhiza. Most plant species form symbiosis with various fungi, in which fungi provide plants with nutrients, while the plant provide carbon to the fungi. In, general studies have found that elevated atmospheric CO_2 enhances the abundance and activity of mycorrhizal fungi, particularly in relation to the production of Spore - bearing structures, while warmer temperatures increase fungal abundance but decrease activities such as soil nutrient transfer to plants. In terms of the global carbon cycle, mycorrhizal fungi could also prove to play a critical role in carbon sequestration in soils. Mycorrhizal fungi reduced plant stress and increase productivity during drought, so the effect of fungal shifts in plant community dynamics is likely to be important; directly linked with tree tolerance to climate change. An uncommon opportunity now exists for converting a potential calamity like climate change into a food for achieving the goal of sustainable agriculture.

Keywords : Climate change, Mycorrhizal fungi, seasons, hazards, drought

INTRODUCTION

Climate change is defined as the long term change in earth's climate due to natural, mechanical and anthropological processes which result in emission of green house gases like CO_2, Methane, etc. These gases settle in the stratosphere and trap the heat within the atmosphere leading to global warming and changing climate patterns. Shifting of seasons, increasing global temperatures, rising sea levels, changing agricultural patterns have resulted in frequent disasters like landslide, tsunamis, drought, famine, population migration and major health hazards not just for us but also for children and grandchildren.

Development is a perpetual process enabling humans to expand and/or realize their potentialities to achieve a greater, better fuller state of living. Utilization of natural resources from the very basis of sustenance of human life,

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while nature has only limited regeneration capacity. Expansion of human population, increase in per capita demand of natural resources and release of chemicals altogether new to natural ecosystem (e.g. chemical pesticides and plastics) innovated by humans over the last three centuries has resulted in global environmental changes with adverse consequences for human well being. The term of sustainable development emerged in the 1980s when it realized that betterment in some spheres of life (e.g. comforts from air-conditioning technologies, dramatic increase in food production by green revolution technologies and rapid economic growth) were achieved at the expense of creation of new problems (e.g. climate change, loss of biodiversity, depletion and degradation of soil and water resources) or aggravation of pre-existing problems (e.g. inequitable development, natural constraints to production of resources needed by human and earthquakes). While advancements in environmental/ ecological sciences established that natural ecosystems had only a limited capacity to withstand, recover from human disturbances, those in social science drew attention to the importance of equitable economic development. As climate change is compounded with other changes in biophysical environment (e.g. changes in atmospheric composition and land use, desertification and biological invasion) and in economic social-political environment, sustainable development approach assumes importance for its scope of addressing multiple problems simultaneously. The areas of special concern to us in India, where agriculture is the predominant source of livelihoods are unfavourable changes in means temperature, excess or deficit in rainfall, more uncertain weather behaviour including extreme weather events, sea level rise, and more frequent and severe coastal stroms and tunamis. From the action taken so far by all nations, particularly by developed countries, it seems likely that the mean temperature will rise by 30^{o}C by the end of this century.

"The areas of particular concern to our country are a rise in mean temperature and a possible rise in sea level. We have to take anticipatory action to insulate lives and livelihoods particularly in vulnerable areas from the adverse impact of unfavorable climate. One strategy should be to maximize the production benefits of good monsoons and minimize the adverse impact of climate change. Although, the consequences of a rise in temperature and poor or excessive precipitation will be general the action plans, both for adaptation and mitigation have to be local. We will have to establish at the Panchayat level, Climate Risk Management Centres and train a cadre of Community Climate Risk Managers".[1]

"Climate change can be a mega catastrophe if we do not take action now, both in area of adaption and mitigation. Anticipatory preparation to potential changes in temperature, precipitation and sea level can help to introduce new technologies in farming. The technological transformation of small scale agriculture and fisheries can be a beneficial outcome. Climate change has already increased the volatility of prices of agricultural commodities. In the future, it will be difficult to import food grainsat an affordable price. An uncommon opportunity now exists for converting a potential calamity like climate change into a tool for achieving the goal of sustainable agriculture".[1]

Further, the traditional agriculture system apparently sustainable at low productivity and at low population pressure. The intensification of agriculture as an inevitable consequence of the compulsion to produce more compounded with rapid and uncontrolled industrialization has put and enormous burden on the natural ecosystem.

Variability of microorganisms found in the global resources of microbes. Soil microorganisms have an important influence on soil fertility and plant health.[2] Plants associate with other life forms (animals, bacteria or fungi) to complete their life cycle, to fight against pathogens, or to thrive in adverse environments. The plants root and its associated living organisms are together called 'rhizoshpere', the region of mycorrhizal association. Arbuscular mycorrhizal (AM) Fungi are a group of obligate biotraphs, to the extent that they must develop a close symbiotic association with roots of a living host plant in order to grow and complete their life cycle. Allen (1991)[3] described the fungal-plant interaction from a more neutral or microbial oriented aspect stating that 'mycorrhiza is a mutualistic symbiosis between plants and fungus localized in a root or root structure in which energy moves primarily from plant to fungus and inorganic resources moves from fungus to plants'. The group of fungi and plants which are involved in the interaction, determines the type of mycorrhiza they form.[4] In addition to increasing the absorptive surface area for interactions with other

microorganisms, and an important path way for the translocation of energy-rich plant assimilates to the soil. Mycorrhizal associations help the host plants to thrive in adverse soil conditions and drought situations by increasing the root surface and mineral uptake efficiency. Environmental threats like increased temperature, changing climate and associated drought, soil infertility, etc. are some of the major challenges in agriculture and have to be mitigated to ensure global food security. In this context, mycorrhiza-based crop production is one of the key components of sustainable agriculture practices.

AM Fungi and Sustainable Agriculture:

As the global population's rapid growth is set to continue, the need to significantly increase agricultural output without increasing pressure on the environment also grows. AM fungi solution enable farmers to derived yield and productivity in a sustainable way. The mycorrhizal symbiosis becomes even more important in sustainable agricultural system where nutrient inputs are low. Under these circumstances AM extra-radical mycelium plays an important role in nutrient mobilization. In nutrient-depleted, tropical regions with excessive rainfall where essential nutrients are leached from soil surfaces, mycorrhizal fungi can extend their external hyphae beyond the depleted zones. As a result, more volume of soil becomes accessible to plant roots. Therefore, plants with mycorrhizal associations are more efficient in the absorption of nutrients like nitrogen, phosphorus, potasium and calcium. Not all plants are dependent on mycorrhizal associations.[5-7] However, in most an increase in yield following inoculation with AM fungi.[8-11] Particularly in low - p Soils[12,13] is observed with the current tendency for reduced use of agrochemicals, research is being directed at crop yield improvement and yield sustainability. The rhizoshpere is the site where microorganisms interact with both plant roots and soil constituents. The higher carbon demand of AM fungi competitively inhibits the growth of the plant pahthogens. Furthermore, the mycorrhizal fungal partner can also improve the nutrient status of the host plant by compensating the loss of root biomass due to pathogen attack by increasing its tolerance. Competitive inhibition of pathogens by endo- and ecto mycorrhizal fungi is demonstrated to protect host plants from disease like root rot, collar disease, etc. The efficient use of AM fungi may allow for the attainment of acceptable yield levels with minimum fertilizer dose while also reducing costs and environmental pollution risk.[14] This is a promising approach for obtaining high yields with low fertilizer inputs in order to support sustainable agricultural systems. AM fungi associations also protect plant against heavy metal toxicity Ectomycorrhizal fungi protect trees from high concentration of toxic heavy metal like copper, zinc, iron, manganese, cadmium, nickel, etc. by accumulating and immobilization them in the mycorrhizal mantle. The plants associated with mycorrhizal fungi also benefit from fungal detoxification systems.

Sustainable agricultural system use natural processes to achieve satisfactory levels of productivity and food quality while decreasing fertilizer use, dropping input costs and preclude environmental pollution and its impacts.[15,16] Sustainable agriculture must, by definition, be ecologically sound, economically viable, and socially responsible. Sustainable agriculture relies on long-term solution using proactive rather than reactive measures at system levels. Research approaches are presently focused on the search for suitable alternatives to the use of commercial artificial pesticides. However, Progress has also been accomplished in exploring the use of microorganisms for improvement of soil fertility and ultimately increases crop productivity. Greater emphasis is being placed on enhancing exploitation of indigenous soil microbes which will contribute to soil fertility and increase plant growth as well as plant protection.

Importance of AM Fungi in Sustainable Agriculture:

In agriculture, several factors influence plant response and plant benefits from mycorrhizas such as host crop dependency on mycorrhizal colonization, tillage, fertilizer application and the potential of mycorrhizal fungi inocula. Interest in AM fungal propagation for sustainable agriculture is increasing due to its role in the promotion of plant health and improvements in soil fertility and soil aggregate stability. These fungi can be utilized effectively for increasing yields while minimizing use of pesticides and inorganic fertilizers. Researchers in the past three decades have established the efficiency of AM fungi in crop production.[17] AM fungi play fundamental role for productivity and stability in horticulture and agro-ecosystems.

Thus there is vast scope for enhancing yield of vegetable crops with AM bio inoculants. In the view of

tremendous potential for AM fungi in maintaining sustainability of agro-based ecosystems, ecological and diversity studies warrant attention. Such studies would provide information essential to attempt to use these AM fungi in sustainable agriculture. AM fungi are an essential below-ground component in the establishment and sustainability of plant communities, butthorough knowledge is required to achieve maximum benefit from these microorganisms and their associations. Microbial solutions provide more choice for farmers and help meet the demand for more sustainable agricultural practices.Such solution can increase crop yields and develop a more sustainable industry impact profile, ultimately resulting in more food to feed growing world and new opportunities to protect the plantlet.

CONCLUSION

Climate change result in emission of greenhouse gases and changing climate patterns have resulted in frequent disasters and major health hazards not just for us but also for children and grandchildren. The areas of special concern to us in India, where agriculture is the predominant source of livelihoods are unfavourable changes in mean temperature, excess or deficit in rainfall, more uncertain weather behaviour AM fungi symbiosis is one of the crucial factors that determine plant and soil health. In addition, mycorrhiza enhances mineral uptake ability and tolerance to drought stress. It also induces resistance against. Soil pathogens and reduces sensitivity to toxic substances in their host plants. But present day practices of agriculture may lead to the destruction of these beneficial associations. Anthropogenic activities like slash and burn cultivation, mining, waste disposal, and clear-cutting of forests are also detrimental to AM fungi. AM fungi are essential component of self-sustaining ecosystem. Thus, nature friendly alternative for agricultural practices like addition of inorganic fertilizers, and can go a long way in maintaining a sustainable environment for future generation. Mycorrhiza represent one of the nature's best gift to mankind in addressing the constraints of enhanced quality productivity with sustainability. The significance of mycorrhiza in augmenting food production and land productivity is accepted and appreciated by scientists and researchers all over the world.

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CONFLICT OF INTEREST

Authors declare no conflict of interest regarding publication or any other activity related to this article.

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