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PREFACE

We are delighted to publish our book entitled "Ecology Research Volume IV". This book is the compilation of esteemed articles of acknowledged experts in the fields of ecology providing a sufficient depth of the subject to satisfy the need of a level which will be comprehensive and interesting. It is an assemblage of variety of information about advances and developments in ecology. With its application oriented and interdisciplinary approach, we hope that the students, teachers, researchers, scientists and policy makers will find this book much more useful.

The articles in the book have been contributed by eminent scientists, academicians. Our special thanks and appreciation goes to experts and research workers whose contributions have enriched this book. We thank our publisher Bhumi Publishing, India for compilation of such nice data in the form of this book.

Finally, we will always remain a debtor to all our well-wishers for their blessings, without which this book would not have come into existence.

\- ***Editors***

CONTENT

CURRENT ISSUES, SOLUTIONS, AND REGULATIONS IN BIOLOGICAL CONTROL: A BROAD ECOLOGICAL PERSPECTIVE

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Abstract:

In order to decrease crop output losses brought on by pest activity and lessen the effects of pest control on both human health and the environment, more robust and sustainable measures are urgently required. Leaders and practitioners in sustainable agriculture, particularly those involved in organic farming and Integrated Pest Management, place a high focus on expanding the use of biological techniques, such as biological control, biopesticides, biostimulants, and pheromones (IPM). Although the use of biological techniques is increasing due to commercial and regulatory pressures, pest resistance to conventional pesticides, and other factors, they still make up a very tiny portion of the world's crop protection inventory. Practitioners and academics from a wide range of areas came together as part of an International Organization for Biological Control (IOBC) project to identify the key obstacles to the uptake of biocontrols and to provide solutions. Risk-averse and cumbersome regulatory procedures; rising bureaucratic barriers to accessing biocontrol agents; a lack of engagement and communication with the general public, stakeholders, growers, and politicians about the significant economic benefits of biocontrol; and fragmentation of the biocontrol subdisciplines were some of the barriers to uptake. In this book chapter we summarise a number of recommendations for the future that place an emphasis on the necessity of effective communication of the economic, environmental, and social successes and advantages of biological control for insect pests, weeds, and plant diseases, targeting political, regulatory, farmers, supervisor, and other stakeholder interests. Discussion is had on political actions taken in certain nations that bode favourably for future biocontrol.

Introduction:

The world's population is still growing, and a fragile natural system must provide for them. As a result, there is increased interest in environmentally responsible and productive agriculture that produces wholesome food while preserving the environment for future generations. Not all productivity-boosting technologies have positive effects on long-term sustainability. For these reasons, it's important to create strategies that are both effective and steady, robust, and sustainable. The definition of biological control is the use of natural enemies to manage disease, weeds, and insects. Although biological control has been practised for centuries, the modern era saw its first significant upsurge of activity after the phenomenal success of the introduction of the parasitic fly *Cryptochaetum iceryae* (Williston) (Diptera: Cryptochaetidae) and the vedalia beetle *Rodolia cardinalis* (Mulsant) (Coleoptera: Coccinellidae) to control cottony-cushion scale (*Icerya purchasi* Maskell) (Hemiptera: Monophlebidae) in California. However, biocontrol use nearly vanished in the mid-1940s as a result of the expansion and success of the synthetic pesticide industry. This continued until the publication of Rachael Carson's "Silent Spring" (Carson, 1962), a book that criticised the use of agricultural pesticides and highlighted their negative effects on wildlife. Due to public outrage over this controversial book, there is now a need for pesticide alternatives, which presents an opportunity for wider use of biological control (Barratt *et al.,* 2010; Gay, 2012). After this debate had hardly subsided, biological control came under examination with claims that its unintended consequences threatened the ecosystem and may even be causing the extinction of non-target species (Howarth 1983, 1991; Clarke *et al.*, 1984). The accusations from environmentalists, especially in the USA, that biocontrol professionals were introducing new species that would spread and reproduce without consideration for species other than pests that might be threatened by these natural enemies enraged those who were exploring alternative options to chemical pesticides. In the end, funding organisations provided resources to address the issues with non-target impacts, and regulators began to demand risk evaluations for biocontrol plans (Sheppard *et al.,* 2003). It became apparent that there was now a chance to conduct some elegant ecological research (Waage 2001), which could broaden the scope of biocontrol beyond its initial emphasis on the discovery, testing, and release of natural enemies to the areas of theoretical and applied ecology where risk assessment could play a key role. These changes appeared to explain and give some agreement between competing viewpoints on the usefulness of using biocontrol as a pest management strategy (Hopper, 1998; McEvoy and Coombs, 2000). Warner *et al.* (2011) examined interests of the public in biological control in organisations in California, USA, and blamed the downturn in biocontrol activity on reevaluated university priorities, increased specialisation in biocontrol science, and challenges growers and interest groups confront when trying to influence science. The International Organization for

Biological Control (IOBC)-Nearctic Regional Section (NRS) President reported recently to the IOBC Global General Assembly (September 2016) that biocontrol is losing ground as an academic subject and that there has been a significant erosion of research positions in US academic institutions (D. Weber, pers. comm., 2016; Messing and Brodeur, 2017). Similar to this, the head of the IOBC Asia Pacific Regional Section has also seen a decline in weed biocontrol research roles in Australia (Palmer *et al.*, 2014). Other regions of the world, such as Europe (van Lenteren *et al.*, 2017), where biocontrol is still a commonly used alternative to pesticides, have seen less of this tendency. The International Organization for Biological Control (IOBC; http://www.iobc-global.org/index.html) is an international organization that advocates ecologically friendly approaches to controlling weeds, insects, and diseases.

Current issues and solutions

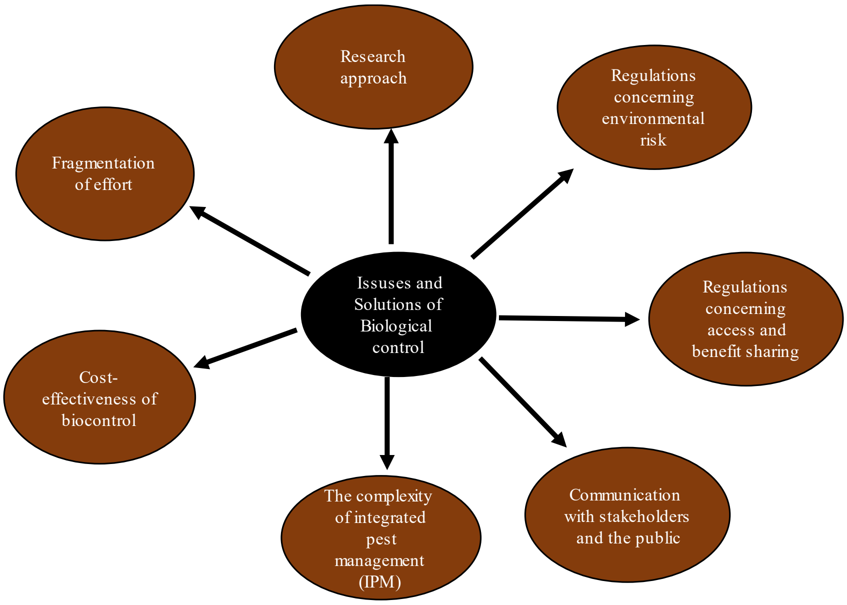

Figure1: Different current issues and solutions of biological control

Regulation of environmental risks

Over the past 20 years or so, authorities have focused more and more on biological control, with many nations mandating risk assessments in an effort to foresee environmental harm. Decisions are made in certain nations based on the balance between risks and rewards (ERMA New Zealand, 1998; Sheppard *et al.*, 2003; Klein *et al.*, 2011), While in other countries, like Australia, where the target status of the pest has already been established, benefits are not taken into account as part of the usual regulation procedure (Sheppard *et al.*, 2003). Regulators seldom demand post-release studies to confirm choices, but when they do, they can provide highly significant data that can be utilised in future decision support (Barratt, 2011). Our capacity to forecast the efficacy and safety of biological control with more accuracy will only increase with more studies like this one that verify predictions made before to release. Regulations can become quite restrictive and risk assessment standards can become very tight in a society that is risk averse. In such a setting, it would appear that decision-makers find it simpler to prohibit the release of biological control agents than to allow them. But then there's the risk that applications for qualified agents may be rejected (van Wilgen *et al.*, 2013). Furthermore, it has been said repeatedly that attempting to advance biological control in risk-averse and highly bureaucratic environments can cause implementation to stall to the point that the practise of biological control becomes unsatisfying and unpleasant (Messing, 2000; Messing and Wright, 2006; DiTomaso *et al.*, 2017). Researchers have lost interest in the system, and fewer scientists now consider classical biological control as a viable career path (Moran and Hoffmann 2015). Due to excessively high-risk aversion and the lack of residual knowledge within the regulatory bodies, some agents in Australia have been unduly delayed in receiving clearance (W. Palmer, pers. comm., 2017). Some nations, like New Zealand, effectively avoid these regulatory delays by imposing a maximum statutory time limit (currently 100 working days from the initial receipt of the application to the making of the decision). The development and facilitation of a standardised, streamlined environmental risk assessment methodology was made possible by biological control practitioners, particularly those in Europe, initially in an EU funded IOBC/biocontrol industry working group (van Lenteren *et al.*, 2003, 2006), and later under the aegis of an IOBC-West Palearctic Regional Section (WPRS) Commission. For the sake of commercial release, this includes a standardised system for the import and research of alien species (OEPP/EPPO, 2014). Complete harmonisation in Europe, however, was not successful, so today it is left to individual nations to regulate themselves using their own, extremely diverse regulatory systems (Bigler *et al.*, 2005, 2006; Bale, 2011).

The rules governing the sharing of benefits and access to them

A key objective of the Convention on Biological Diversity (CBD) is to ensure fair and equitable distribution of the benefits obtained from genetic resources (Convention on Biological Diversity, 1993). It is referred to as 'Access and Benefit Sharing' (ABS). It is widely recognized that genetic resources belong to countries, and that agreements governing access to them and benefits derived from their use should be drafted. Nagoya Protocol, adopted in 2010, is the instrument used to implement ABS (Secretariat of Convention on Biological Diversity, 2011). It was recognized by the IOBC early on that the introduction of IABS could introduce considerable bureaucracy into the process of exploring and using biocontrol agents (Cock *et al.*, 2010). In order to report to the Food and Agriculture Organization of the United Nations (FAO) the International Organization for Biological Control and ABS established a Global Commission on Biological Control and ABS. As a result, CABI contributed to the writing of the report, which contributed to the FAO Commission on Genetic Resources for Food and Agriculture's programme (Cock and van Lenteren, 2009; Cock *et al.*, 2009). In its review of biocontrol practices globally, the IOBC Commission highlighted those characteristics of biocontrol that should exempt it from being considered part of a protocol that was primarily designed to protect countries from being exploited for profit by large commercial companies. The IOBC Commission did a number of recommendations which were presented at many policy meetings related to ABS. As a result of this request, the IOBC Commission has produced a new document describing 'best practice' for ABS in relation to biological control (Mason *et al.*, 2017).

Communication with the public and stakeholders

The public and stakeholders (including managers of productive lands and conservation lands) are usually not well informed about biological control. Historically, biological control has not been integrated well into conservation land management, although successful projects have been undertaken in recent years (van Driesche and Rearden, 2017). The author of Van Driesche (2017) provided an overview of biocontrol in natural areas, as well as the social and regulatory aspects involved in its successful implementation. Public opinion on biocontrol is often negative, usually supported by historical examples, such as vertebrates that have been used for biocontrol. Cane toads in Australia, mongooses in Hawaii (Else, 2011), etc., are examples often luridly and repeatedly publicized, which perpetuate and erode public support for biocontrol, despite their numerous successes. These spectacular failures happened at a period when there was little to no scientific supervision of the initial pest issue or its effects. Similarly, scenarios in which scientific data is altered to reflect unfavourable consequences of exotic natural enemy releases might have a long-term detrimental impact on the employment of biological control. As previously stated, the IOBC wants to publish and extensively distribute a fit-for-purpose publication in an accessible style that may provide positive information concerning biological control advantages to a variety of non-specialist interest and policy groups, as well as the general public. As a first step, the IOBC will produce a compact, well-illustrated compilation of brief case studies demonstrating successful biological control across a variety of agents and targets, geographical locations, and industries. A publication of this type would be aimed at regulators, stakeholders, policy groups, students, and the general public, and would serve as an educational tool and information resource to dispel some of the negative misinformation about biological control while also promoting its positive benefits and successes.

IPM complexities

IPM, and biological control in particular, may be rather complicated systems involving several stakeholders, each of whom may have different expectations and needs. Changes to management techniques can be difficult and have an impact on producers' profitability, and to a lesser extent, managers of conserved property. Therefore, farmers and land managers need to be able to comprehend what is being suggested to them and why, and they typically want to see a financial gain from adopting new or alternative techniques, at least in the long run. If they elect to use new pest control techniques, they will need to devote time to installation, monitoring, and training in their particular setting (e.g. van Lenteren *et al.,* 2017). New methods that use fewer or no pesticides may increase the value of agricultural goods and the environment, creating new market prospects for IPM products in oversupplied food markets (Lefebvre *et al.,* 2015). Direct and indirect economic benefits (such as subsidies, free advisory services, improved market access for products, prevention of pesticide resistance, and regulation to protect the environment and people from exposure to pesticides) are the main drivers for growers to switch from a pesticide-based management system to IPM. According to studies comparing how European customers appreciate IPM vs conventionally grown items, people are prepared to pay greater costs for IPM products. However, the apparent price premium is frequently fairly tiny (Lefebvre *et al.,* 2015). In the lack of an official European label, these authors found that selling IPM goods is challenging, and the premium is not a significant incentive for farmers. There are now 56 separate and certified schemes (labels) for foodstuffs in the European Union that relate to Integrated Production and IPM, which may be an impediment to improved IPM adoption and consumer acceptance. The Organisation for Economic Cooperation and Development (OECD) has identified three methods in which governments and policies may encourage and sustainably support biocontrol and IPM (OECD 2012). First, there is an outcome-based policy in which the government sets risk reduction goals through the use of biological control and IPM while leaving implementation and achievement to market forces; second, there is a facilitative policy in which the government uses policy measures as an incentive to make biocontrol and IPM attractive to farmers by supporting a broad suite of tools for research, knowledge transfer, decision making support, and so on. In its report (OECD, 2012), the OECD recommends that governments implement a facilitative policy to encourage IPM adoption by creating incentives such as short and long-term financial mechanisms and support to ensure the continuity and sustainability of

IPM and to prevent growers from reverting to conventional, pesticide-based production. For example, while the European Union has made IPM mandatory for all farmers beginning on January 1, 2014 (European Union, 2009), an increase in advisory services has been identified as an important indirect subsidy to support farmers with the technical and economic knowledge required for IPM adoption (Lefebvre *et al.,* 2015). To assist overcome unfavourable attitudes regarding biological control in IPM systems, farmers and extension advisers must be included in decision-making processes on a timely basis. Growers, managers, and advisers must grasp the advantages and disadvantages of adopting IPM to an existing crop/natural environment vs their current methods. Not only must IPM practitioners assist farmers and managers in comprehending the complexities of IPM systems, particularly if biocontrol is a critical component, but researchers must also understand the context in which these techniques will be applied. A collaboration formed early on between researchers, extension workers, and producers is likely to produce the best results for all parties. Private or public extension advice services are seen as essential participants in this area (OECD, 2012). Growers must be encouraged to employ IPM on a long-term basis in order to reap the long-term advantages, and to avoid farmers reverting to traditional production techniques when issues arise. Scientists' communication and information should be clearly understandable and in plain language, tailored to the demands of stakeholders and taking regional peculiarities into account. This is especially true in developing nations, where language barriers, long-standing customs, and the demand for immediate returns are difficult to overcome. FAO, CABI, and other international assistance agencies have effectively employed a more participatory strategy in which researchers and consultants may help groups of farmers in attending training sessions or 'farmer field schools' (FFSs). Farmers may attend FFSs and cultivate crops in a community atmosphere where they can learn how to monitor pest issues and engage with their peers and trainers to discuss IPM strategies (e.g. see Wyckhuys, this issue). Modern communication technologies are becoming more economical and accessible in both developed and underdeveloped countries. Smartphones, tablets, and laptops are all tools that may be utilised to help producers make better decisions. This shift toward ICT-based Extension (Information Communication Technology) is proving to be a great instrument for reaching a large number of farmers with timely and easy-to-implement guidance. There are several ICT extension programmes across the world that provide pest-related information, seasonal alerts, field identification, distribution maps, fact sheets, and publications that are accessible via smart phones and other devices. The CABI-led Plantwise initiative, which supports the Plantwise Knowledge library, is one of the most comprehensive (CABI, 2016). Plantwise has also created plant clinics across the world, particularly in poor countries, that are administered by qualified extension officials and give assistance through pest diagnosis and management advice, including biological treatment methods (Dougoud et al., this issue). Web-based pest detection and control solutions aimed at farmers and growers are becoming more widespread in other nations. In New Zealand, AgPest is an online tool for farmers that allows them to detect pests and weeds in pasture, acquire information on the biology of the pest and weed, and management recommendations, including biological treatment (AgPest, 2016). This is a free website where farmers may sign up for pest forecasts and notifications targeted to their specific interests and location of the country. The IOBC database on pesticide side effects is another useful online resource. Farmers may use this information to rapidly determine which pesticides they can use in conjunction with the natural enemies they have introduced.

Biocontrol's ability to reduce costs

Practitioners of biological control frequently struggle to show how their programmes are profitable and beneficial in other ways. There are two issues. First off, the political level lack of cost-effectiveness evidence for biocontrol programmes has discouraged governments from funding biocontrol research and development, which in turn has decreased academics' interest in doing research or engaging students in biological control education. Second, at the grower level, farmers and land managers who have not been actively involved in the biocontrol or IPM programmes implemented on their production systems may see only slow progress or no initial impact on pests and believe that it is not providing financial benefits in comparison to pesticides that appear more reliable and predictable. While some of these concerns are obvious, a deliberate and united effort by leaders in biological control such as CABI, IOBC, and major research organisations and academic institutions may encourage and enable economic studies to be conducted and published as a result of the programme. Despite the fact that biological control is likely unrivalled in terms of return on investment in IPM, little economic studies have been conducted to far (Naranjo *et al.*, 2015). Using data from BIOCAT (Greathead and Greathead, 1992), these authors suggested that historically, the advantages obtained by traditional biological control programmes that worked more than compensated for those that failed. The benefit:cost ratio for traditional biocontrol has been stated to be 250:1 when compared to the expense of manufacturing an effective pesticide, where the ultimate benefit:cost ratio has been determined to be between 2 and 5:1. (Bale *et al.*, 2008). The later authors observed that the benefit-to-cost ratios for augmentative biological control were lower and comparable to pesticides, but with far reduced development costs. A recent study conducted in New Zealand for the biological control of Sitona obsoletus Gmelin (Coleoptera: Curculionidae), the clover root weevil, by the braconid parasitoid Microctonus aethiopoides Loan (Hymenoptera: Braconidae), revealed that the return on NZ$8.3 million invested in exploration, research, and introduction of the parasitoid has been NZ. This yearly return is based on the premise that farmers would continue to rely on clover for nitrogen fixation (which has been decreased by insect larvae feeding on root nodules) and that the current level of biological control will stay steady (Hardwick *et al.,* 2016). The Australian Weed Management Cooperative Research Centre published research on the economic implications of 45 target weed biocontrol programmes (Page and Lacey 2006). Almost half resulted in a financial advantage, with a benefit:cost ratio of 23:1.

Approach to research

Much biocontrol research and implementation has tended to be crop or pest specific, resulting in a bottom-up approach. We believe that pursuing a more holistic or ecological top-down approach may have advantages. Rather of thinking about how to control a specific pest, the formative issue may be: how can we ensure food security in a healthy biosphere? While this work is not the place for a discussion of sustainable agriculture, there may be significant benefits to conducting research in which biological control is only one aspect of providing nutritious food or sustaining natural ecosystem function and ecosystem services. Researchers are becoming increasingly interested in this topic, and significant effort is being made to improve our knowledge of the link between biodiversity, ecosystem function, and ecosystem services. The economic value of ecosystem services given by naturally existing predators, parasitoids, and diseases has been estimated to be enormous (Power, 2010). This field of biological conservation control entails controlling or managing agricultural or natural ecosystems in such a way that existing natural enemies are promoted and resourced to favour natural enemy survival (Landis *et al.,* 2000). Kean *et al.* (2003) found that focusing on the most critical areas of natural enemy ecology would aid conservation biological control the most. According to Heimpel and Mills (2017), there are essentially two ways to boosting natural enemy efficacy: manipulating the ecosystem to benefit natural enemies at the expense of pests (e.g. increasing resources, habitat quality), and reducing pesticide impacts on natural enemies (e.g. more selective chemicals, improved spatial and temporal use of pesticides). The possibility for biological control conservation in poorer nations has also been highlighted (Wyckhuys *et al.,* 2013). Population genetics research provides chances to better understand how biological control's influence might be optimised. The introduction of agents with a large genetic variety is clearly likely to aid in adaption in a novel environment for traditional biological control (Wright and Bennett, 2017).

Recent discoveries, such as CRISPR gene editing, may be better adapted to augmentative biocontrol, allowing for the reduction of less desired features in biological control agents (flight, diapause) and the insertion of new desirable qualities such as pesticide resistance (Gurr and You, 2016). 'BINGO' (Breeding Invertebrates for Next Generation Biocontrol Control) is a project that aims to increase the production and performance of biocontrol agents via the use of cutting-edge genomic technology (Pannebakker and Beukeboom, 2016). In general, biological management is used to reduce pest populations below economically viable levels. Many people have pointed out that quantifying parasitoid attack rates or parasitism percentages does not offer information regarding population effect (van Driesche *et al.,* 1991; Barlow *et al.*, 2004; Barratt, 2011). In some circumstances, a 90 percent assault rate for an r-selected pest species (very fecund but low offspring survival) will be ineffective. Similarly, in weed biocontrol, records of the establishment and growth of herbivorous agents, as well as their feeding-impacts on the target host, may not always indicate success. Only measurements of the agents' impacts on target plant populations (changes in density and distributional range), which are complex, typically take decades, and are compounded by problems of seed dynamics and seed reserves, can provide a solid case for biocontrol effectiveness (Hoffmann and Moran, 1998; Moran and Hoffmann, 2012). Pre-emptive biocontrol, which increases the speed with which a biological control agent may be administered if the advent of a new pest is thought to be imminent, can help to 'fast-track' a biocontrol programme. Biosecurity intelligence and border interceptions in New Zealand have indicated the potential for pests such as the hemipterans Homalodisca vitripennis (Germar) (glassy-winged sharpshooter) (Hemiptera: Cicadellidae) and Halyomorpha halys Sta 'l (Hemiptera: Pentatomidae) (brown marmorated stink bug) to arrive. Research to predict the potential distribution or impact of such pests (Charles and Logan, 2013) or the impact of such pests (Charles, 2015) can be very beneficial, and even risk assessment conducted in quarantine prior to the arrival of the pest (Charles *et al.*, 2016) has the potential to speed up the regulatory process if the need arises. Basic biological research, notably in taxonomy, ecology, and behaviour, has significantly improved processes utilised in biological control agent exploration, selection, and risk assessment. Furthermore, because to research in the fields of population dynamics, population genetics, and modelling, we now have a strong general grasp of how biological regulation works. We think, however, that improved collaboration between basic and applied scientists has huge potential for more cost-effective biocontrol research and implementation.

Future perspectives and conclusions:

At the moment, convincing farmers throughout the world to take a systems approach to pest management and more biological control may be difficult. Nonetheless, in a pesticide-dominated agricultural business, biological control has found a place in the form of augmentative releases, notably for the management of pests that are difficult to control with insecticides. Each pest species is connected with tens to hundreds of natural enemy species (parasitoids, predators, and diseases), and hence thousands of natural enemies remain undiscovered. The identification and pre-release assessment of natural enemies, including ERAs, has substantially improved over the last 40 years (van Lenteren & Manzaroli, 1999; Bigler *et al.*, 2006), with more than 150 species of natural enemies being commercially accessible for augmentative biological control (van Lenteren, 2003). Natural enemies that are inefficient or dangerous may be recognised easily using the criteria of existing evaluation techniques, saving money on useless research. Improved networking across the world's biological control community, as well as the creation of freely available databases collecting information on all researched natural enemies (with proper evaluation), will aid in the identification of novel and efficient control agents. Once a suitable natural enemy has been identified, it is critical to teach the extension service and farmers in its use, an area of biological control that is sometimes overlooked. Farmers are capable of quickly selecting the most appropriate pest management strategy for their crops as a result of self-learning and experimenting, as demonstrated by FAO Farmers Field School (FFS) projects in Asia and Africa, and rapidly shifting away from chemicals to cultural methods and biological control (Ooi & Kenmore, 2005). A FFS adaption might be regarded as a technique of attaining sustainable pest management in the industrialised world as well. However, biological control practitioners will need to spend time raising society understanding about the advantages of sustainable and ecologically friendly pest management, or else conventional chemical control will continue to dominate control alternatives. Though it is clear that biological control programmes have been successfully implemented in a wide range of agricultural situations around the world, and the potential for biological control to play a larger role (particularly in IPM), adoption and implementation of this technique of control remains sluggish. Ecologically sound pest control has not been applied for a wide range of pests and diseases due to technical and economic hurdles, but mostly cultural barriers. Although funding for biological control research is limited, we believe that the main constraints are related to the attitudes of advisory personnel and farmers, as well as the pesticide industries' disinterest in anything other than chemical control, and policymakers' hollow endorsement of alternative methods, which has yet to be matched by a realistic investment in research and development. We are certain, however, that biological control will play a significant role in future pest management since it is the most sustainable, cost-effective, and ecologically safe form of pest management, with extra benefits for producers and consumers. By 2050, biological control is predicted to account for a much higher share of all crop protection measures.

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AGROFORESTRY- NEW WEAPON TO FIGHT CLIMATE CHANGE

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Abstract:

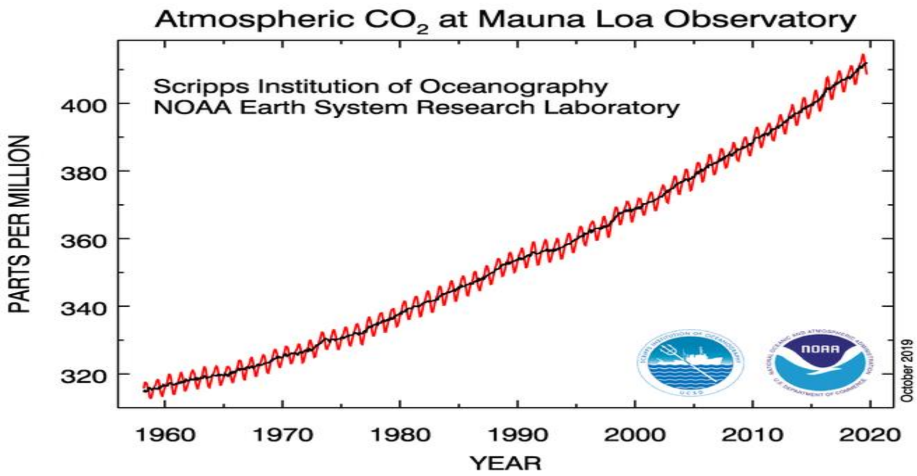
Mitigation and adaptation with climate change (CC) is critically important for sustained health and environmental quality. This chapter presents agroforestry as a new weapon in climate change fight through storage and sequestration of carbon available in atmosphere in the form of biomass. Agroforestry system recognized as a carbon sequestration strategy because of its applicability in agricultural lands as well as in reforestation programs and offers the highest potential for carbon sequestration as carbon sequestration rates ranges from 1.5 to 3.5 Mg C per ha per yr in agroforestry systems and also have some indirect effects on carbon sequestration since it helps to reduce pressure on natural forests. CSP (Carbon sequestration potential) of existing AFS (Agroforestry system) at farmers field at Country level is 0.21 tons of C /ha/year while carbon dioxide mitigation potential of AFS at country level is 0.77 tons of CO_2 /ha/year. At national level, AFS are estimated to mitigate 109.34 million tons CO_2 annually. AFS are estimated to offset one-third (33%) of the total GHG (Greenhouse gases) emissions from agriculture sector annually at country level. AFS has the potential to mitigate more than 6% of total GHG emissions in India. AGF can regain 35% of carbon stock & store soil carbon at rate of 80 – 100% that of forest, compared to 12% and 50 % respectively on crop or pasture land. AGF have a technical mitigation potential of 1.1-2.2 Pg C in terrestrial ecosystems over the next 50 years.

Keywords: Agroforestry, Climate change, Carbon sequestration, Mitigation, Global warming

Introduction:

Today, intensive agricultural practices emit several green house gases into the atmosphere and developing countries contributes about three-quarters of direct emissions of GHGs of the total world's emission (Paustain *et al*., 2004; Moreau *et al*., 2012). Some practices like flooded rice cultivation and enteric fermentation release methane (CH_4) in the atmosphere, microbial transformation on nitrogenous fertilizers and manures releases nitrous oxide (N_2O) whereas change in biogeochemical cycles, biomass burning and organic residue decomposition affects our environment through emission of carbon dioxides (CO_2) (Chirinda *et al*., 2018). Similarly, the process of deforestation has been intensifying the level of GHGs and promotes the burning issue of global warming leads to changing our climate (Scott *et al*., 2018).

Rising CO_2 is correlated with this rise in temperature



In this context, there is a need to adopt and modified natural ecosystems to more friendly and sustainable agricultural system, which can fulfill the human needs as direct and indirect services along with environmental health through minimizing the continuous emission of GHGs. Therefore, climate-resilient agro ecosystem practices like conservation farming and agroforestry systems (AFs) are very good option for both enhancing the soil and plant productivity in the parallel of carbon sequestration (CS) capacity in the vegetation and soil (Jhariya *et al*., 2015; Singh and Jhariya, 2016).

Agroforestry

Agro forestry is a collective name for land use system in which woody perennials are grown with herbaceous crops and/or animals on the same land by spatial arrangement (or) temporal sequence (Lundgren and Raintree, 1983). Climate change (CC) event can be adapted through the scientific practices of various location specific agroforestry models which is good strategy for minimizing the deleterious impact changing climate through diversifying the structure and productivity which helps in atmospheric carbon fixation in the vegetation parts, promotes close and efficient nutrient cycling along with enhancement of SOC pools and enhance the production of goods and services in the sustainable ways along with carbon offset credits through better practices and management of AFs (Jhariya *et al*., 2015; Singh and Jhariya, 2016).

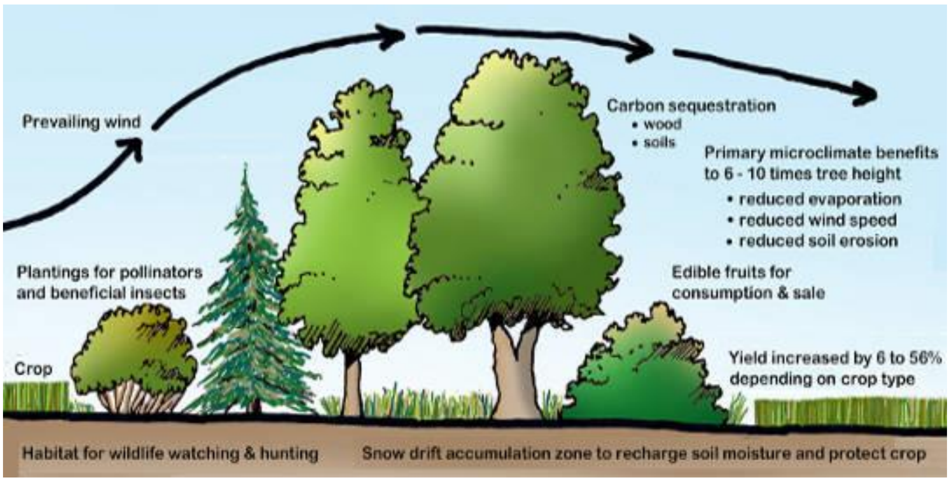
Agroforestry gains wider recognition due to its wider adaptability and applicability in the tropics and multifunctional role in resource conservation, production potential as timber, fuelwood, biofuel and non- timber forest products (NTFPs) including storing of atmospheric carbon into the vegetation and soils. Thus the intimate mixture of agroforestry elements (trees, crops, and animals) are the basis of sustainable land use system, which is socioeconomically viable and ecologically acceptable (Nair, 1979). Therefore, agroforestry has wider recognition in the biomass production enhancement, soil fertility improvement, storage and sequestration of carbon and biofuel (Fanish and Priya, 2013).

Carbon sequestration and storage are gaining wide recognition due to its properties of reducing green house gases (GHGs) in the atmosphere and mitigating climate change and global warming phenomenon by fixation of atmospheric carbon into vegetation and soils. This carbon fixation has two benefits, *i.e.*, first represent lowering the excessive heat in our environment whereas, second represents stored carbon which represents biomass production in terms of timber, fuelwood, biofuel and NTFPs which helps in livelihood security (Parihaar, 2016; Sudha *et al*., 2007 and Alavalapati and Nair, 2001).

Agroforestry as new weapon in climate change fight

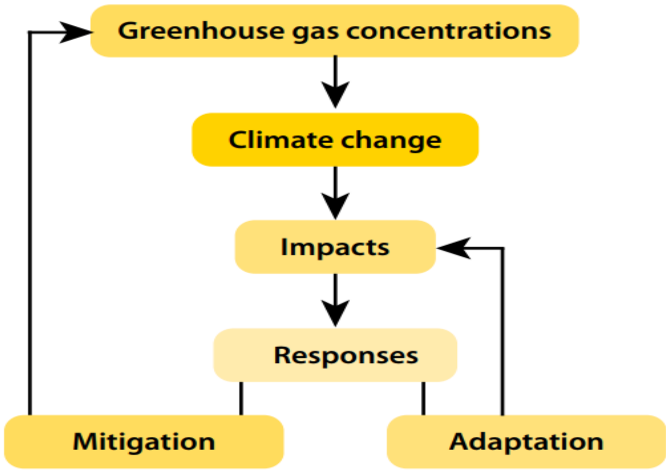
Agroforestry could play an important role in mitigating climate change because it sequesters more atmospheric carbon in plant parts and soil than conventional farming. It is involved in carbon capture and the long-term storage of atmospheric carbon dioxide and this process is critical in mitigating or deferring global warming.

The conversion from forest to agroforestry led to losses in soil organic carbon stocks in the top layers, while no significant differences were detected when deeper layers were included. The conversion from agriculture to agroforestry increased soil organic carbon stocks at all levels, in most cases. Significant increases were also observed in the transition from pasture/grassland to agroforestry in the top layers, especially with the inclusion of perennial plants in the systems, such as in silvopasture and agro-silvo-pastoral systems. Through agroforestry climate change either can be mitigated or adapted to it.



Mitigation and Adaptation

The mitigation addresses the cause of climate change and is an intervention to reduce the emission sources or enhance the sinks of the GHGs. Although, adaptation addresses the impact of climate change and is an adjustment in the natural or human system in response to actual or expected climatic stimuli or their effects.



Agroforestry for mitigating climate change

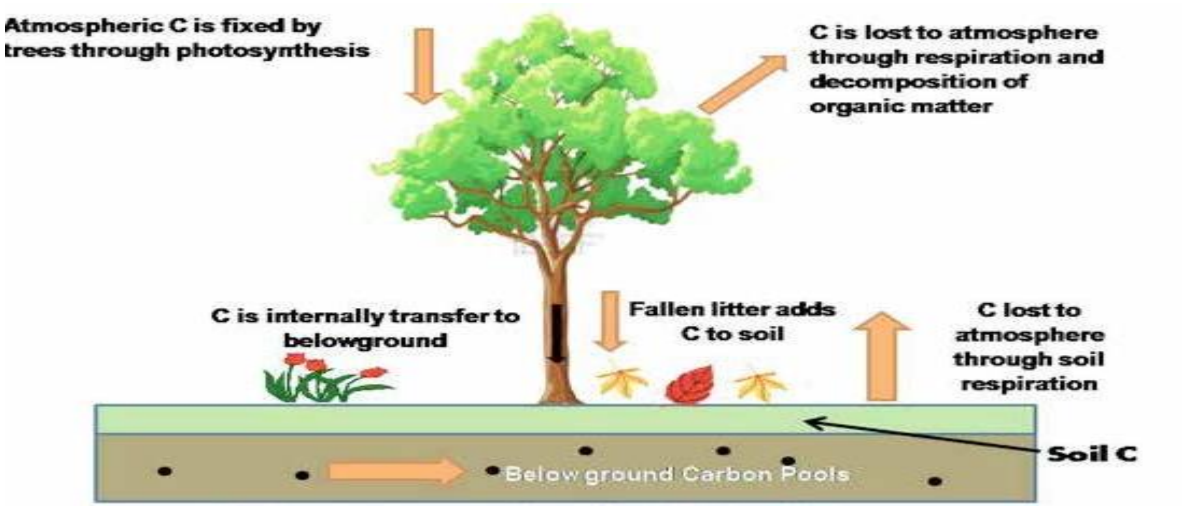
Agroforestry has potential to limit carbon emissions, sequester atmospheric carbon, microclimate amelioration, protection and stabilization of ecosystem, soil and water conservation, sustainable diversification of agricultural systems, improvement in rain water efficiency and interventions for drought mitigation

Contribution of AGF in CC M&A (Source: Mbow *et al*., 2014)

	Livelihood	Mitigation	Adaptation
Carbon benefit	Income	+++	+
Wood energy	Asset	+++	++
Buffer climate risks/water recycling	Asset	++	+++
Improve ecosystem resilience microclimate /soil fertility	Asset-Income	+	+++
Ecosystem services: Food/fruits/medicine	Asset-Income	-	+++
Reduce pressure on natural forest	Asset-Income	+++	+

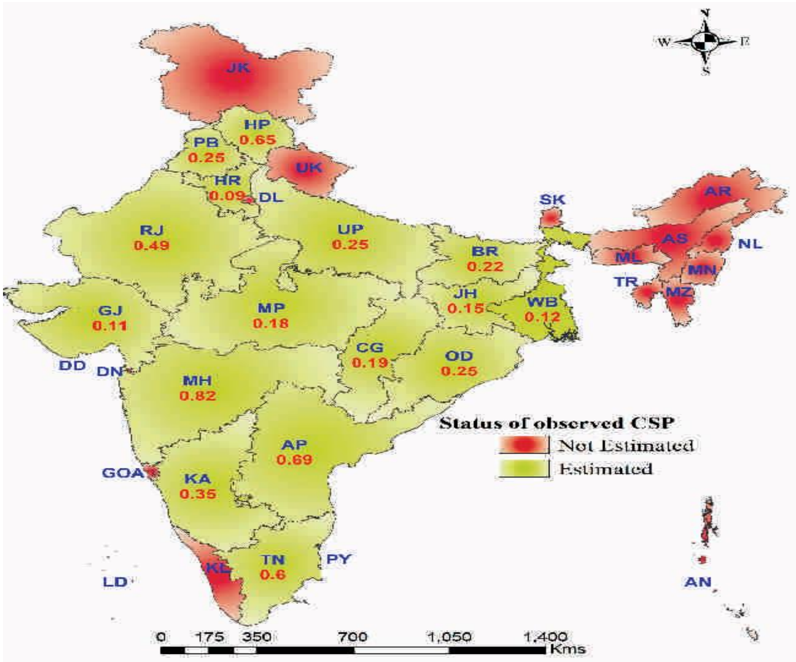
+++: high positive impact, ++: positive impact, +: limited positive impact,

-: zero positive or potential negative impact



Carbon sequestration through agroforestry is one of Best options for Climate Change Mitigation

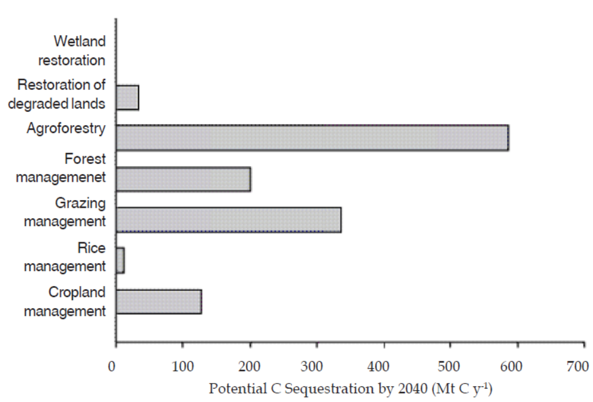
Agroforestry system recognized as a carbon sequestration strategy because of its applicability in agricultural lands as well as in reforestation programs and offers the highest potential for carbon sequestration as carbon sequestration rates ranges from 1.5 to 3.5 Mg C per ha per yr in agroforestry systems and also have some indirect effects on C sequestration since it helps to reduce pressure on natural forests. Agroforestry accumulate C in woody biomass, Soil and thus reduces GHG emission.

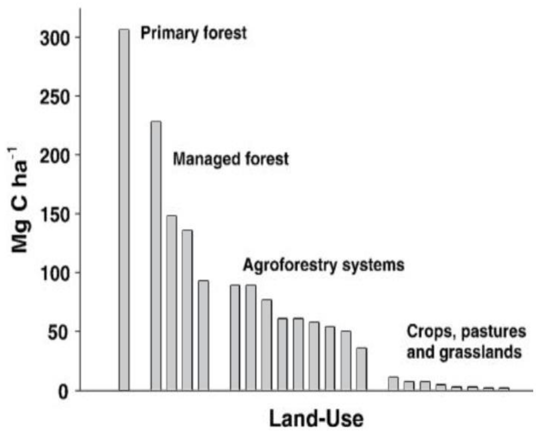


Carbon Sequestration potential in agroforestry system existing on farmer's field in India (CAFRI, 2018, Annual report 2018-19)

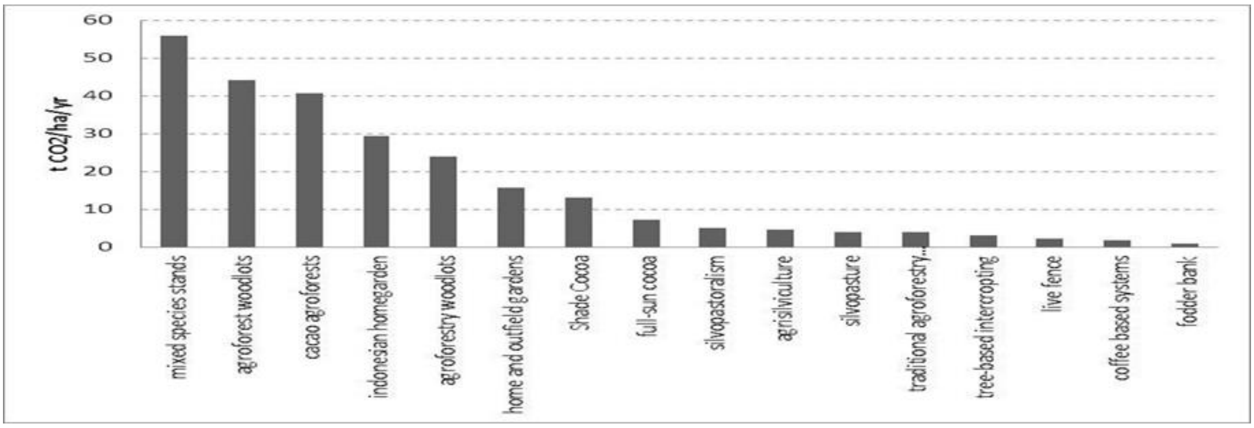
Carbon sequestration potential of different land use management system

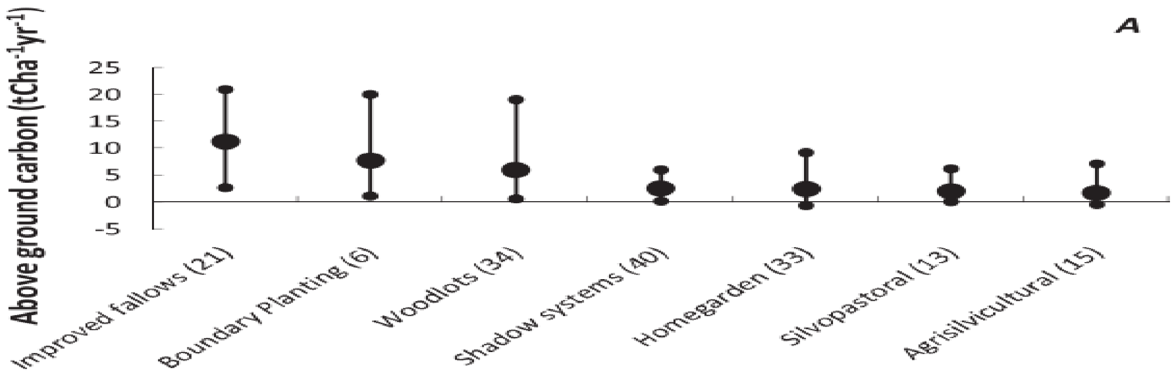
Agroforestry systems recognized as having the highest potential for the carbon sequestration by year 2040 among all the land uses analyzed in the Land-use and Land-use change.

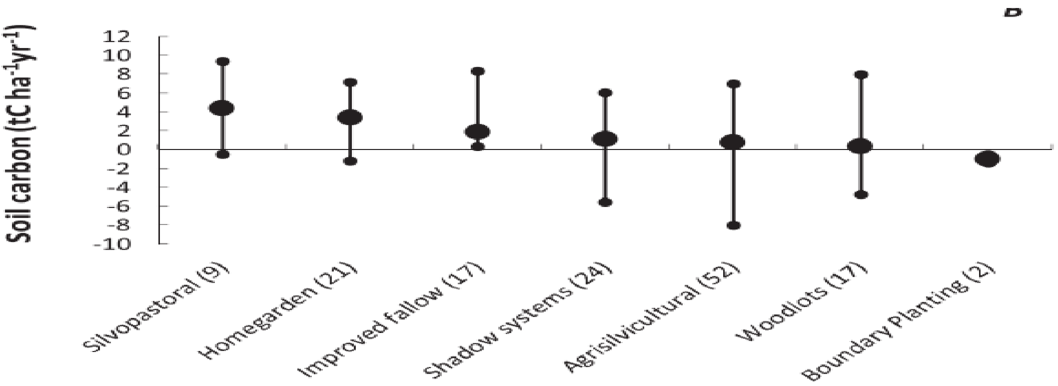




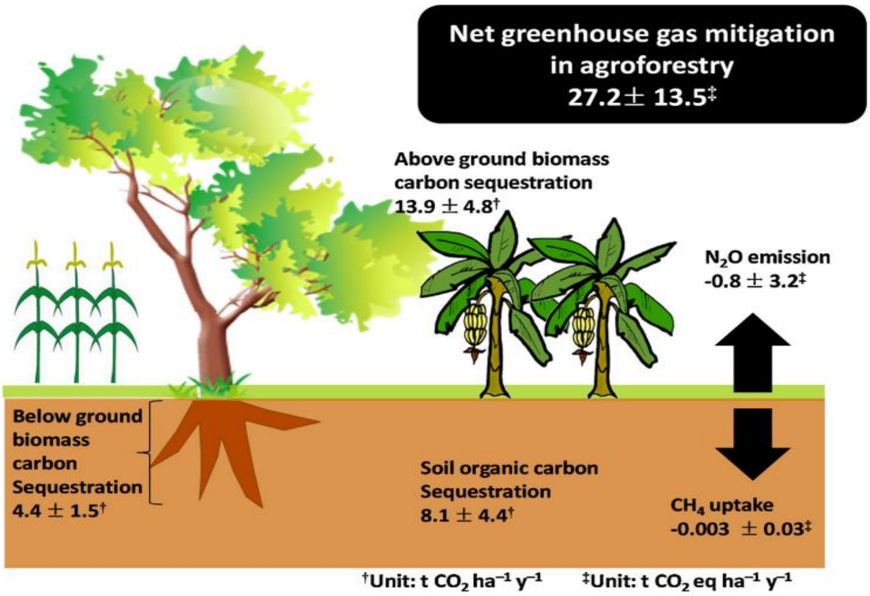
IPCC, 2000 **Verchot *et al*., 2007**







Mean, maximum and minimum above ground (A) and soil (B) carbon sequestration in different agroforestry systems. Number of observations (n) is presented in brackets. (Feliciano *et al*., 2018)



Rate change in CS, CH_4 & N_2O emissions mitigation by converting agriculture to AGF

Carbon Sequestration Potential (CSP)

CSP of existing AFS at farmers field at Country level is 0.21 tons of C /ha/year while carbon dioxide mitigation potential of AFS at country level is 0.77 tons of CO_2 /ha/year. At national level, AFS are estimated to mitigate 109.34 million tons CO_2 annually. Considering the reported GHG emissions from agriculture sector as 334.41 million tons of CO_2 equivalent in India (Indian-Network-for-Climate-Change-Assessment, Report-2010, Govt. of India), AFS are estimated to offset one-third (33%) of the total GHG emissions from agriculture sector annually at country level. AFS has the potential to mitigate more than 6% of total GHG emissions in India (Ajit *et al.* 2017). AGF can regain 35% of carbon stock & store soil carbon at rate of 80 – 100% that of forest, compared to 12% and 50 % respectively on crop or pasture land (Palm *et al*. 2004; Watson *et al*., 2000). AGF have a technical mitigation potential of 1.1-2.2 PgC in terrestrial ecosystems over the next 50 years (Solomon *et al*., 2007). Unproductive lands (630 million ha) can be converted to AGF, can have additional carbon sequestration potential of 586,000 Mg C yr-1 by 2040 (Jose, 2009).

The carbon absorption capacity of different agroforestry models (Toppo and Raj 2018)

Agroforestry model	**Carbon storage capacity**	**Region**
Agrisilviculture system (aged 11 years)	26.0 t C/ha	Semiarid region
Block plantation (aged 6 years)	24.1–31.1 t C/ha	Central India
Populus deltoides 'G-48' + wheat	18.53 t *C/ha*	
Silvopasture	31.71 t C/ha	Himachal Pradesh
Agrisilviculture	13.37 t C/ha	
Agri-horticulture	12.28 t C/ha	
Silvopastoralism (aged 5 years)	6.55 Mg ha–1 y–1	Kerala, India
Indonesian homegardens (aged 13.4 years)	8.00 Mg ha–1 y–1	Sumatra

Estimated biomass, carbon and carbon sequestered under agroforestry systems (Rizvi *et al*., 2017)

Baseline and Simulated biomass carbon		**Agro climatic zone-8**						
		Guna	**Hosangabad**	**Panna**	**Dausa**	**Pali**	**Lalitpur**	**Hamirpur**
Total Biomass (tree+ crop) Mg DM ha^{-1}	**Baseline**	9.55	11.16	7.83	12.88	17.19	35.57	26.5
	Simulated	16.45	16.88	12.13	30.51	39.11	58.12	37.37
Soil carbon (Mg C ha^{-1})	**Baseline**	23.38	17.75	17.95	16.49	16.5	9.70	8.35
	Simulated	24.80	19.42	19.12	17.01	16.92	14.30	14.56
Biomass carbon (Mg C ha^{-1})	**Baseline**	4.31	5.06	3.54	6.09	7.95	16.80	12.32
	Simulated	7.59	7.80	5.61	14.55	18.47	27.63	17.54
Total carbon (biomass + soil) (Mg C ha^{-1})	**Baseline**	27.61	22.81	21.49	22.58	24.45	26.50	20.67
	Simulated	32.39	27.22	24.73	31.56	35.39	41.93	32.1
Net CS AFS over the simulated period of thirty years (Mg C ha^{-1})		4.78	4.41	3.24	8.98	10.94	15.43	11.43
Estimated CSP (Mg C $ha^{-1}yr^{-1}$)		0.15	0.15	0.11	0.29	0.36	0.51	0.38

The contribution of agroforestry to global and national carbon budgets

Agroforestry and tree cover on agricultural land make an important contribution to climate change mitigation**.** 24% global GHG emission is from agricultural production and ongoing land use change**,** 43% of all agricultural land globally had at least 10% tree cover in 2010. Based on this analysis, these land-use types represent over 1 billion hectares of land and provide subsistence to more than 900 million people. IPCC Tier 1 estimated 45.3 PgC carbon storage of tree cover on agricultural land globally, with trees contributing >75%. South America and South-East Asia have by far the largest carbon stocks on agricultural land. (Zomer *et al*. (2016), Nature Science Report).

Estimated biomass, carbon and carbon sequestered under existing AFS in various districts of selected states of India (Ajit *et al.*, 2017)

Baseline and Simulated biomass carbon		H.P.	Punjab			Haryana		U.P.
		Mandi	Faridkot	Ludhiana	Nawansahar	Hisar	Kurukshetra	Sultanpur
Tree Biomass Mg DM ha^{-1}	Baseline	10.69	0.58	2.88	6.70	0.78	0.97	2.56
	Simulated	24.86	0.96	4.67	6.71	2.40	3.00	8.24
Total Biomass (tree+ crop) Mg DM ha^{-1}	Baseline	26.77	12.18	25.97	23.91	17.54	7.96	11.14
	Simulated	41.39	12.91	28.41	24.94	19.63	10.18	17.05
Soil carbon (Mg C ha^{-1})	Baseline	22.28	9.02	9.12	6.95	10.31	9.1	8.13
	Simulated	24.98	10.32	24.51	11.31	12.89	9.75	8.63
Biomass carbon (Mg C ha^{-1})	Baseline	12.05	5.27	11.21	10.30	7.58	3.48	4.92
	Simulated	19.04	5.61	12.45	10.90	8.57	4.53	7.75
Total carbon (biomass + soil) (Mg C ha^{-1})	Baseline	34.33	14.29	20.43	17.25	17.89	12.49	13.05
	Simulated	44.02	15.93	36.96	22.21	21.46	14.28	16.38
Net CS AFS over the simulated period of thirty years (Mg C ha^{-1})		9.69	1.64	16.53	4.96	3.57	1.80	3.33
Estimated CSP (Mg C $ha^{-1}yr^{-1}$)		0.32	0.05	0.55	0.16	0.12	0.06	0.11

GHG Mitigation potential of different land uses with barren land as base (Jha *et al.*, 2003)

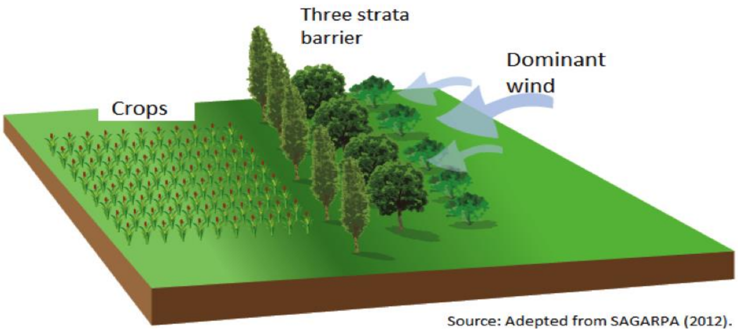
Land use	SOC store	Mitigation Potential (up to 30 cm soil depth)
Barren land	20.0 t / ha	1.00
Pasture	40.0 t / ha	2.00
Agriculture	66.0 t / ha	3.30
Plantations	80.5 t / ha	4.02
Agro-forestry	83.6 t / ha	4.18
Forest	120.0 t / ha	6.00

Reported carbon sequestration potential (Mg C/ha/yr) of various AFS in India (Ajit *et al.*, 2017)

Location	Agroforestry System	Tree Species	No. of Tree Spp.	Age	CSP[mg C/Ha/Yr	References
UK	Agrisilvi	*D.Hamiltoni*	1000	7	15.91	Kaushal *et al.*, 2014
HP	Agrisilvi	Fruit trees	69	-	12.15	Goswami *et al.*, 2014
Khammam,AP	Agrisilvi	*L. leucocephala*	4444	4	14.42	Prasad *et al*. 2012
UK	Agrisilvi	*P.deltoids*	500	8	12.02	Singh & Lodhiyal 2009
Punjab	Agrisilvi	*P . deltoids*	740	7	9.4	Chauhan *et al.*, 2010
KKR, Haryana	Silvipasture	*A . nilotica*	1250	7	2.81	Kaur *et al.*, 2002
Tripura	Silviculture	*T.grandis*	444	20	3.32	Negi *et al.*, 1990
Tarai region,UK	Silviculture	*T. grandis*	570	10	3.74	Negi *et al.*, 1995
Jhansi,UP	Agrisilvi	*A . procera*	312	7	3.7	-
Jhansi, UP	Agrisilvi	*A . Pendula*	1666	5.3	0.43	Newaj and Dhyani 2008
Hyderabad,AP	Silviculture	*Lebbeck*	625	9	0.62	-

Adaptation to climate change

Adaptation to CC through AGF Alter microclimate to reduce extreme weather impact on crop, maintain quality and quantity of forage production, reduce livestock stress, greater structural and functional diversity, diversified product to reduce fluctuating climate risk and travel corridors for species migration. Shelterbelts and wind breaks in arid Rajasthan for micro-climate mediation and crop cultivation is the best example for climate moderation Windbreaks form efficient soil protection against wind erosion particularly at the time when soil cover is not protected by the cultivated plant vegetation cover. Windbreaks may reduce wind speed by 60 to 80 per cent (SAGARPA, 2012). Long term research in sustainable agriculture proves that trees in the agro landscape help agriculture productivity and increase resilience to climate change (Singh *et al.*, 2012).



Source: Adepted from SAGARPA (2012).

Conclusion:

It can further be concluded that rise in level of CO_2 since 1960 has tremendously affected the global temperature regimes which results in global warming. To mitigate unavoidable climate change effect, Agroforestry provides win-win situation as it helps to increase the natural forest base which helps to supplement carbon sequestration potential of our forests. AGF readily bundle both mitigation and adaptation strategies (synergies) and provide several pathways to securing food security for poor farmers, while contributing to climate change mitigation. Windbreak and shelterbelts provides a strong protection against the fast moving dry and hot winds in arid and semi arid regions hence, help to maintain and modify the microclimate and maintain the biodiversity which help to overcome the ill effects of changing climate

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INSECT VISION AND IT'S POTENTIAL USE IN PEST MANAGEMENT: AN ECOLOGICAL APPROACH

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Abstract:

The capacity to distinguish between two light wavelengths is known as colour vision. Compound eyes, ocelli, stemmata, and simple dermal light receptors are only a few of the different kinds of light receptors found in insects. While the compound eyes of many insects are known to be sensitive to blue, green, and ultraviolet (UV) wavelengths, only a small number of insects have demonstrated behavioural colour vision. Accordingly, colour vision has been proven in honeybees, some dipterans, and few other insects. A thorough test for colour vision requires behavioural evidence that an insect has been able to distinguish between two colours (i.e., two wavelengths of light). Insect compound eyes seem to share a lot in common with vertebrate eyes in terms of the visual process and visual cascade. Numerous insects clearly depend on their vision for their ecology and behaviour in order to locate oviposition sites, mates, and food sources. Of course, olfaction may contribute to some or all these processes. *M. sexta*, the tobacco hornworm, lacks red receptors but contains UV, blue, and green receptors. When an olfactory stimulus (oil of bergamot, a known attractant for the moths) was combined with a visual signal (a white paper flower) in flight tunnel testing, *M. sexta* moths responded best by flying upwind. The moths responded to both when the two stimuli were provided separately, preferring the visual display more strongly, but responding to both less strongly than when both stimuli were offered simultaneously.

Keywords: Photoreception, Bichromatic insects, Trichromatic insects, Visible Spectra

Introduction:

For two key reasons, researching the evolutionary ecology of insect colour vision should be fruitful. The first is realising the huge variety of visual circumstances that insects work in, such as the fact that some dwell in dirty freshwater and fly at night and that others have colonised habitats like caverns, lush tropical woods, and glaciers. From Greenland to the The second benefit of researching the evolutionary ecology of insect colour vision is that colour receptors appear to be widely varied between species, providing significant room for evolutionary adaptation. If only certain eye regions are considered, as in the frontal eye of the owlfly Ascalaphus macaronius, one species of insect may have as few as one different spectrum receptor type. This is the situation for some flies (Gogala, 1967; Hardie, 1986). These photoreceptors' spectrum coverage varies greatly between species. The range of wavelengths that A's frontal eye can detect. The spectral receptor types found in some species of butterflies, dragonflies, and hymenoptera (Meinertzhagen *et al.,* 1983; Horridge *et al.,* 1984; Paul *et al.,* 1986; Yang *et al.,* 1991; Peitsch *et al.,* 1992; Arikawa *et al.,* 1997; Briscoe, 2000) cover visual ranges that are among the broadest ever described in animals. Macaronius is sensitive is relatively narrow [from 300 to (from 700 nm). Sexual dimorphisms are common in insects, and different parts of their eyes frequently have receptors with varying spectral sensitivity (Stavenga, 1992). (Bernard *et al.,* 1991). Additionally, the maximum sensitivity values and the shape of the spectral sensitivity functions might vary between species (Hardie, 1986; Peitsch *et al*., 1992; Cronin *et al.*, 2000).

Despite all the variation, arthropod photoreceptor wavelength placement appears to follow conservative patterns. It is surprising that creatures occupying utterly different ecological niches, like the beach isopod Ligia exotica (Hariyama *et al.*, 1993), the nocturnal hawk moth *Manduca sexta* (White *et al.,* 1994), the freshwater bug *Notonecta glauca* (Bruckmoser, 1968), and flower-visiting Hymenoptera (Chittka, 1997), have remarkably similar sets of UV, blue, and green (Ichikawa *et al.,* 1982). Without knowledge of insect history, it is impossible to comprehend how insect colour vision evolved.

Consequently, most of the review's discussion of adaptation revolves around phylogeny and molecular biology. The study of evolutionary adaptation using other methods, including as population studies, biogeography, selection experiments, and fitness assessments, is still in its infancy (Chittka *et al.,* 2000)

Photo reception

Photoreceptors, a type of specialised light-sensitive cell found in the eye, are what are known as photoreceptors and are responsible for the mechanisms of light detection that enable vision. Light is perceived by insects through several different receptors.

Different photoreceptors involved in vision:

1. Compound eyes 2. Stemmata 3. Ocelli

Compound eyes

In arthropods, compound eyes serve as visual organs (insects and crustaceans). A compound eye is made up of a variable number (from a few to thousands) of tiny eyes, called ommatidia, which serve as independent photoreception units and have an optical system (a cornea, lens, and sometimes some accessory structures), as well as typically eight photoreceptor cells. The photoreceptors in ommatidia, which are oriented to receive light from different directions and are defined by the optics of the ommatidia, the curvature of the eye, the spacing arrangement, and the density of the ommatidia, form a "neural picture" in the compound eyes instead of an image like the large lens eyes of vertebrates and octopi. Depending on how isolated the ommatidia are from one another and how light is focused into the photoreceptors, the optical system exhibits a wide range of changes. The three main types are the apposition eye, in which the ommatidia are optically isolated (as in locusts and beetles; typically in day-active insects), the superposition eye, in which the ommatidia are not optically isolated (as in butterflies; usually in crepuscular or night-active insects), and the neural superposition eye, in which the ommatidia are optically isolated but neuronal arrangement results in partial pixel summation (found in diurnal flies) (Land, 1981; Stavenga, 2006).

Ocelli

The "dorsal ocelli" or "ocelli" are a collection of basic eyes that are present in both adult insects and non-holometabolan larvae. These structures receive dorsal innervation between the optic lobes from the protocerebrum. Normally, there are three ocelli at the midline of the skull, although the number ranges from zero to three. There are basically four dorsal ocelli, but one pair is fused to form the median ocellus (eight in Collembola). Although little is known about exactly what they observe and how they work with the compound eyes, their role appears to be visual.

Stemmata

The larvae of Holometabola contain the second group of simple eyes, originally known as "lateral ocelli" but now known as "stemmata" (plural stemma). Stemmata normally have a group on either side of the skull and are innervated laterally by the optic lobes. There can be zero to seven stemmata, and their quantity and placement can provide diagnostic information. They are typically less well grown, fewer in number, or non-existent in larvae found in concealed circumstances, and are most fully developed in externally fed larvae such as caterpillars, sawfly larvae, and predaceous larvae. The larvae found in hidden situations are often less fully developed, less in number, or non-existent, whereas the externally fed larvae, such as caterpillars, sawfly larvae, and predaceous larvae, are the most fully developed.

Do insects have colour vision?

Almost of insects are capable of seeing the entire colour spectrum. They are also able to distinguish between a single colour and a combination of colours. most insects can see when UV and yellow are combined. Blue green colour is the appearance of the UV Yellow combo. Some insects' eyes make the colour white appear blue. The groundbreaking research of Karl von Frisch has revealed for the first time that'simple organisms' like insects are capable of colour vision (1914). He trained honey bees to recognise a certain colour from 30 various degrees of grey by conditioning them to coloured cardboards.

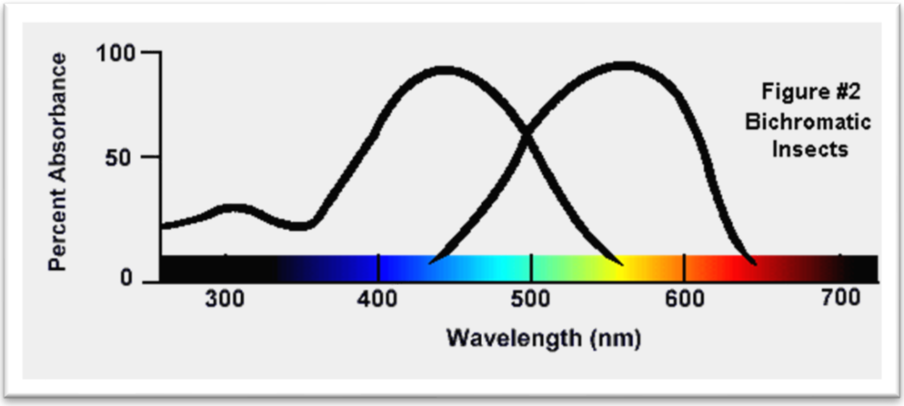
Most insects have maximal sensitivity to ultraviolet wavelengths, while others exhibit maximum absorption in the blue range.Most insects do not have eyes that are stimulated by the colour red. Color vision makes it easier to recognise objects and improves our ability to evaluate their quality. Many insects have colour vision that is sensitive to UV light as well as longer wavelengths, which enables them to see patterns on flowers that are invisible to the human eye.

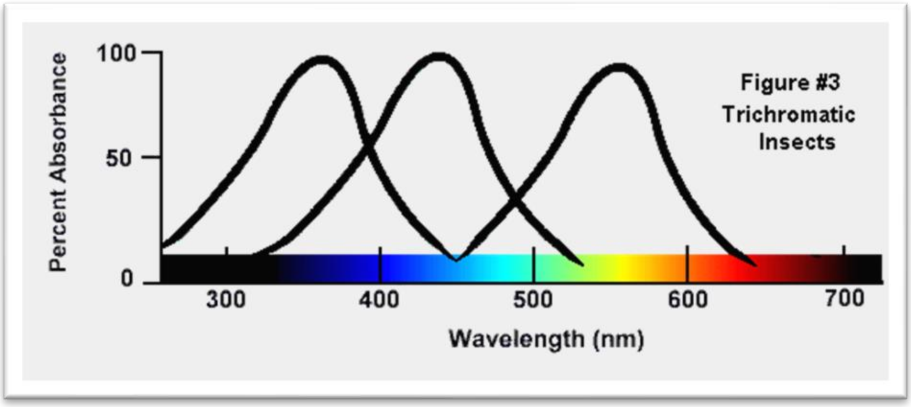
Bichromatic insects vs trichromatic insects

Insects classified as "bichromatic" have only two types of colour pigment receptors and frequently struggle to distinguish between pure colours and colour combinations. For instance, the yellow and UV pigments would both absorb light at 500 nm (blue-green) similarly and would cause an equivalent response in both receptor types. However, combinations of light (such 450 nm and 550 nm) could similarly equally excite both receptors; the insect was unable to distinguish between this mixture and a single colour at 500 nm.

True colour vision is only found in honeybees, bumblebees, and many nocturnal butterflies. With absorption peaks at 360 nm (ultraviolet), 440 nm (blue-violet), and 588 nm yellow, they have three visible pigments. Within the limits of their spectral sensitivity, these "trichromatic insects" are able to distinguish between single colours and colour combinations as well as the entire colour spectrum. A bichromatic insect would see the combination of UV and yellow (opposite ends of the bug's visual range) as "blue-green" since both receptor types are activated. However, a trichromatic insect would be able to distinguish such colour combination because the "blue-violet" receptor is not activated.

Studies on behaviour show that bees view the UV-yellow combination as a distinct "colour". We refer to it as "bee-purple" in the bee's colour scheme since it corresponds to the colour "purple" in the human colour scheme. Similarly, wavelengths that stimulate the bee’s UV and blue-violet receptors (but not the yellow receptors) would produce a unique stimulus known as “bee violet” in the bee's colour scheme.





Visible spectra for different insects

Insects can see colours that are lower in wave length and higher in frequency. According to behavioural research, Indian Meal Moths were most drawn to UV (365 nm) and green (500 nm) lights, which may indicate that the eyes are bichromatic. Moths were more drawn to high-intensity light than low-intensity light. Bees and monarch butterflies may use UV patterns in the sky for orientation and navigation, according to behavioural research. Schistocerca gregaria, a desert locust, has a unique eye that is most sensitive to polarised blue light, which is probably an adaptation for nocturnal flight.

The results of electrophysiological and micro spectrophotometric experiments revealed that flies have a UV receptor with a peak centred between 340 and 360 nm. The assumption that insects see colour and are particularly sensitive to shorter wavelengths of the visible spectrum and UV light is supported by experimental research. Different light intensity can produce different responses. In their 1941 study, Weiss *et al.,* examined the colour reactions of seventeen different species of beetles. A small percentage of the beetles were found to be drawn to longer wavelengths (yellow-orange, orange-red, and infrared). Wavelengths from 365 to 528 had the highest stimulating efficiency, with about 60% of the beetles responding positively to that band if wavelengths (violet-blue, blue, and blue-blue-green) are considered to be one unit.

Honey Bee: UV light is sensitive to bees. They can only see blue colours. They are red blind.

American cockroach: Possesses UV and green light sensors.

Aphids: Contains green, blue and ultra-violet photoreceptors.

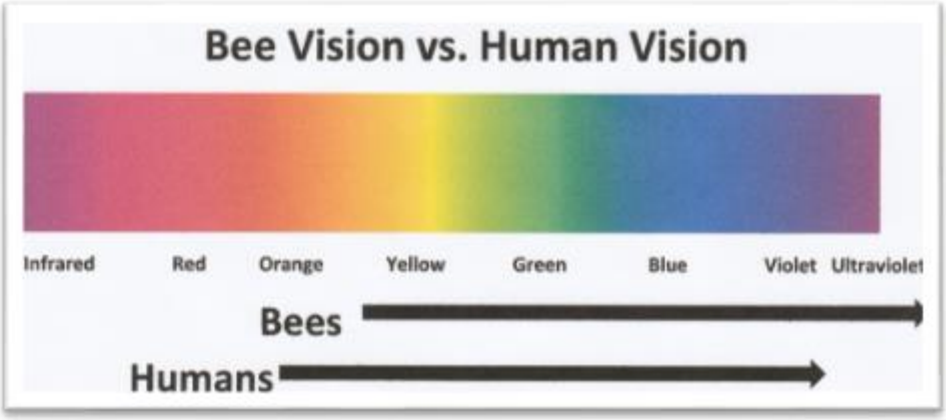
Papilio rutulas can distinguish night from the day and can perceive colours in a high frequency (trichromatic vision).

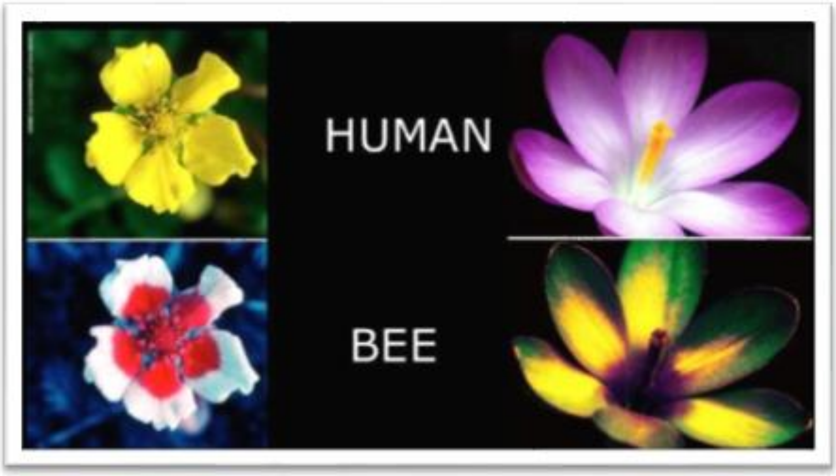
Infrared detecting systems are used by beetles (*Tetraopes tetraphthalamus*) for night vision, fire detection, and other purposes, such as to detect forest fires.

Mosquitoes are attracted to black and to dark colours.

Odonata can perceive orange to ultraviolet light.

Human vision vs insect vision





Although there are many visual parallels between insects and humans, there are also significant distinctions. The structure of the eye is the most noticeable. The majority of non-insect species' eyes, including human eyes, are single-lens devices. The compound eye of an insect is made up of several lenses. Color vision is another significant variation between how

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insects and other creatures perceive light. Humans can generally see electromagnetic spectrum wavelengths between 400 and 800 nanometers, or from violet to red. On the other hand, insects can see light with wavelengths between 300 and 650 nanometers, including ultraviolet light.In compound eyes, the visual acuity is depended on the number and size of the ommatidia in the eye. In the human eye, the visual acuity is depended on the photosensitive cells density in the retina. As a result, the human eye is roughly a hundred times better than the compound eye of the insect.

Chemistry of insect vision

A photochemical reaction is the initial occurrence that produces a visual image. Rhodopsin, a pigment found in rhabdomere microvilli, is an absorber of light quanta. Rhodopsin undergoes a chemical change as a result. which in turn causes depolarization, activation of Na+ and Ca2+ channels, and electrical activity in the retinula cells' axons. As a result, the pigment converts light energy into chemical energy, which the neuron subsequently converts into electrical activity. One photon of light can trigger a reaction in retinal cells.

The visual pigment found in all animal cells that are sensitive to light is known as rhodopsin. It is made up of the chromophore 3-cis-retinal or a chemically similar protein called opsin. The chromophore in insect eyes can either be 3-cis-retinal or 3-cis-2-hydroxy retinal. (Vogt, 1983; Vogt and Kirschfeld, 1984; Smith and Goldsmith, 1990). Typically, rhodopsin is classified according to its maximal spectrum sensitivity, such as a UV-sensitive rhodopsin or a blue-sensitive, green-sensitive, or red-sensitive rhodopsin. A family of G-protein coupled receptors includes rhodopsin. Second messengers in a signalling process, G-proteins are intracellular proteins. Opsin is a transmembrane protein having seven a-helical domains that makes up the protein component. Variable amino acid counts and sequences give opsin (and, naturally, rhodopsin) species specificity and control its spectrum characteristics (Zhukovsky and Oprian, 1989). The plasma membrane of the retinula cell contains a "pocket" of opsin that holds the retina. Because of a covalent link that was created between the aldehyde group of retinal and the epsilon amino group of lysine residue 296 in transmembrane 7 of the protein, retinal is retained as a protonated Schiff base(Zhukovsky *et al.*, 1991). A glutamate residue in transmembrane 3 has an induced negative charge that balances the proton of the Schiff base (Zhukovsky *et al.*, 1991). The distribution of electrons surrounding the retinal chromophore and inside the opsin portion of rhodopsin shifts as a result of amino acid alterations in opsin, particularly in the transmembrane 3 and transmembrane 6 domains, changing the maximum wavelength of light absorption (Briscoe and Bernard, 2005) conclude that the difference between the slightly blue-shifted rhodopsin (R522, i.e., the Amax) in the malachite butterfly, When an amino acid is substituted at position $138A in the peacock butterfly's opsin, a tuning shift toward the blue area results, causing Siproeta stelenes and R530 in the peacock butterfly, Inachis io.

Potential of insect vision in pest management

Some nocturnal diurnal insects may be drawn to light sources. Artificial light sources are less effective (or completely ineffective) for pest control during the daytime due to the intensity of the sun. It is well known that coloured traps can be employed to catch nocturnal pests. Examples of these include yellow pan traps and yellow sticky traps. Important crop pests like planthoppers, leafhoppers, aphids, whiteflies, thrips, and leaf miner flies are attracted to these yellowish gadgets. The use of yellow sticky rolls or plates has proven crucial for the physical management of these pests.

Insects are known to fly toward streetlights or other types of outdoor lighting at night. The design of electric insecticides is based on this natural phototactic tendency. The insect assassins effectively attract insects like moths and beetles and deter them from entering greenhouses and stores that are open at night thanks to their UV-emitting neon tubes. The development of pest management technology that makes use of insects' reactions to light as a "clean" alternative to synthetic pesticides has attracted a lot of interest in recent years.

Why are night-flying insects attracted to lights?

One explanation is based on the observation that insects travel at night using UV light. The insect's ability to travel is hampered by a point source of light, such as a flame or a lightbulb. As a result, the insect that is seeing UV light loses its bearings and starts circling the light.

It has been demonstrated that the use of UV-absorbing plastic films that block near-UV light radiation (300–400 nm) in greenhouse farming is successful at keeping certain pests out of greenhouses. The near-UV region of light is extremely sensitive to insect eyes, and many species rely on UV vision for orientation. It is assumed that a UV-absorbing greenhouse will appear dark to these insects. When given access to both a space containing UV radiation and a space with no near-UV radiation, many species of insects choose to stay away from the latter.

Fruit in orchards is harmed by fruit-piercing moths like Eudocima spp. and Oraesia spp. By turning on the yellow fluorescent lights in the orchard at night, damage can be avoided. This tactic takes use of the fact that nocturnal behaviours like flying, sipping fruit juice, and mating are suppressed by light adaptation in moths when they come into contact with light that is brighter than a particular threshold at night. In addition to preventing damage to chrysanthemums and carnations from the cotton bollworm *Helicoverpa armigera* Hubner, damage to green perilla from the common cutworm *Spodoptera litura* (Fabricius), and damage to cabbage from the webworm *Hellula undalis* Fabricius, this method of behaviour suppression using yellow fluorescent light is also used to prevent damage to other plants.

Recently, nighttime moth management has also benefited from the development of green fluorescent lamps. Similar to yellow fluorescent lamps, these lamps reduce the behavioural activity of some moth species, although they have less of an impact on plant growth overall. Additionally, because to the fact that LED lighting is getting much more affordable, yellow-emitting LEDs have lately been used to regulate the activity of nocturnal moths. From ultraviolet to red, LEDs are capable of producing very monochromatic lights (lights with a limited range of wavelengths). Future practical use of LEDs are anticipated, and their optical property makes them advantageous for regulating pest behaviour.

Conclusion:

Insect physiology, insect behaviour, molecular biology, biochemistry whatever the field, an entomological study is focussed on, it will always be from the perspective of pest management. So how can we use the insect vision for pest management through pest survilence, pest monitoring and push pull technology.

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ISOLATION OF *ALTERNARIA ALTERNATA FROM* INFECTED LEAVES OF *ALOE VERA* TO STUDY THEIR MORPHOLOGICAL BEHAVIOUR

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Introduction:

Aloe barbadensis is a perennial, drought-resisting, xerophytic plant belonging to the family Liliaceae. The leaves are 40-60 cm long, erect, broad, thick and fleshy succulent, glaucous-green in colour, narrow lanceolate in shape with long acuminate tip with small thorns on both edges. Central bulk of the leaf contains colourless. Mucilaginous pulp (aloe vera gel), made up of large, thin walled mesophyll cells. The plant contains 95-96% water and over 75 other constituents which include vitamins, minerals, enzymes, sugars, phenolic compounds, saponins and amino acids. The folk name of this plant is "kanniedood", which means "can-not die".

Material and Methods:

Collection of infected leaf spot samples of leaves showing characteristic leaf spot symptom were collected from the field. The infected leaves were kept in rough dry envelop and marked clearly mentioning characters and date of collection etc., and brought to the laboratory for isolation of the pathogen. The dry glassware's were sterilized at 160°C for 1hr in hot air oven (Aneja and Singh, 1989).

Method of isolation

Diseased samples, showing distinct characteristics of specific disease, were selected for isolation of the pathogen. The selected plant parts were washed with fresh sterilized water to remove the dust particles. The washed diseased plant parts were cut into small bits, with some healthy portions, with the help of sterilized scalpel. The cut pieces were surface sterilized with 0.1 percent mercuric chloride solution under aseptic condition inside the laminar flow. The Petri-dish used in the experiment were sterilized at 160°C for 1 hr in hot air oven and poured with 2 percent potato dextrose agar (PDA) medium and after one or two pieces of infected leaf parts were transferred in each Petri-dish with the help of sterilized needle. The Petri-dishes were properly marked with glass marking pencil indicating date of isolation and isolate number etc. Petri dishes were then transferred at 28-2°C in incubator.

Cultural and morphological characters

Characteristics of the fungus were studied on PDA, 20 ml of sterilized medium was poured into each Petri plate and allows solidify. The Petri plate was inoculated with actively growing mycelia disc (5mm) and incubated at (28-2°C).

Pure-culture of the pathogen

The purification of the fungi undertaken following single spore isolation technique. A dilute spore suspension was poured in Petri-dish to form a very thin layer on it and spores allowed to settle down on the agar surface, settled spores were separated out from each other, selected under the microscope.

Purification

The purification of the isolated fungi was undertaken following single spore isolation technique. A dilute spore suspension was poured on Petri dish containing medium to form a very thin layer on it and spores allowed to settle down on the agar surface, settled spores were separated out from each other, selected under the microscope and encircled with the help of dummy cutter in Petri dish and were lifted along with agar blocks and transferred to Petri dish containing sterilized 2 percent PDA, after proper growth of the fungi obtained by single spore culture, regular sub-culturing were done to check contamination, till pure culture was not obtained. These cultures were sub-cultured at 15 days interval and maintained on PDA slants under refrigeration at 10 to 12°C for further studies. The purified isolate of the fungal pathogen was labelled. The entire procedure of isolation was done under laminar air flow (Bello and Ello, 1988).

Characterization pathogen and identification

The symptoms appeared on the leave of small dark brown necrotic spots which gradually enlarge to cover up an area of 2-8 cm in diameter. The infected area transforms from dark brown to black. The identification of fungi was made by preparing slides of the fungi and observing them under microscope. The fungi mounted on slides, stained with lacto phenol-cotton blue, on the basis of morphological and cultural characteristics using manuals. The fungal colony was olivaceous black with dark olive-green margins, and abundant branched septate, golden brown mycelium, the conidiophores were branched, and straight, golden-brown and smooth walled (Bhatt *et al.*, 2000).

Pathogen city test

Pathogenicity test was conducted on *Aloe barbadensis* leaf was placed in 30 petri plates, inoculated with spore suspension of *Alternaria alternata* using moist sterilized filter paper, plates were incubated at 25+ 2°C and were regularly observed for development of symptoms. Their isolation was done to confirm the test pathogen from infected portion of the leaves taken for pathogenicity test were cultured in Petri plate and incubated at 25 2°C. Olivaceous black colonies with dark olive-green margins, and abundant branched septate, golden brown mycelium growth similar to that of test fungus appeared after 7 days of incubation in petri plate. Slides were prepared and examined under microscope. The cultural and morphological behaviour of the pathogen was similar to the standard pure culture proves its Pathogenicity (Boudreau and Beland, 2006; Infantino *et al.*, 2009).

Figure 1: Infected leaves of Aloe vera black spot disease

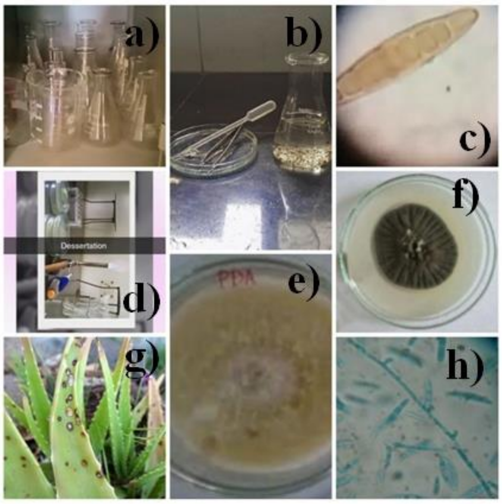

Figure 2: a) Different apparatus for isolation of pathogen, b)Conical flask containing collection of Aloe vera black spot c) Under Light microscope show the *Alternaria alternata* d) The pathogen *Alternaria alternata* grow on the PDA (Potato Dextrose Agar) e) Plate containing the high growth of pathogen *Alternaria alternate* f) **growth of pathogen *Alternaria alternate*. g) Infected leaves of Aloe vera black spot diseases h) Under Light microscope show the *Alternaria alternate***

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GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM *NERIUM OLEANDER* L. EXTRACT FOR ENHANCED ANTIMICROBIAL EFFICACY

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Introduction:

Nano particles are a heterogeneous group of substance which varies in size (1-100nm) and structure. In future nanoparticles study expands rapidly, since the obtained nanoparticles possess unique electrical, optical as well as biological properties. Thus they are applied in catalysis, bio sensing, imaging, drug delivery nanodevice, fabrication and medicine. In the past few years, there has been an increasing interest in nanoparticles because of the anti-microbial, anti-fungal and anti-mycobacterium property. The rapid development of the biosynthesis of metal nanoparticles using plant and animal extracts (Abdel-Fattah and Ali, 2018). Many studies have also focused on the investigation of the reduction mechanism using plant extract (Almeida *et al.*, 2004). Employing these principles towards nano science would facilitate the production and processing of inherently safer nonmaterial's and nano structured devices (Avval *et al.*, 2020). Metals such as gold (Au), copper (Cu), zinc (Zn) and silver (Ag) and titanium (Ti) are considered as models that were extensively used for the synthesis of nanoparticles (Hassanien *et al.*, 2012; Burlacu *et al.*, 2013; Horikoshi and Serpone, 2013; Baetke *et al.*, 2015).

Materials and Methods:

Selection of medicinal plant

The present study was carried out by with the selection of medicinal *Nerium oleander* plant

Collection of plant material

A plant was collected from Nanded district. The plant parts was selected for biosynthesis of nanoparticles

Selection of pathogens

The microorganisms like *Staphylococcus aureus* and *Micrococcus luteus* was used for ant-bacterial property and it was obtained from Microbial Type Culture Collection. The cultures will be subculture and maintained in agar slants (Kharissova *et al.*, 2013).

Biosynthesis of nanoparsticles

The nanometals like CuO, ZNO, Ti, $AgNO_3$ etc. Mixed with fresh plants parts and washed repeatedly with distilled water. 5 gm of plants parts will finely cut and boiled with 100 ml of distilled water for 5 min to get the extract. The crude extract thus developed, undergone a filtration method by using Whatman No.1 filter paper. To optimize this reaction, the following method will adopted:

100 ml aqueous filtrate of plant parts extract has being taken into 250 ml conical flask. Then the extract was mixed with nanometal solution, to make the final volume concentration of 1 mM aqueous solution. This reaction mixture was kept uninterrupted until its dark brown colour change was arisen (Kozower *et al.,* 2013).

Spectral analysis of nanoparticles

Synthesized nanoparticles will be confirmed by spectral analysis

UV spectroscopy analysis

The absorption spectra were measured with a Perkin Elmer Lambda 35 UV-Visible Spectrophotometer with a 1 cm quartz cell.

FT-IR spectroscopy analysis

FTIR spectra recorded at room temperature using the spectra of the capped nanoparticles which measured with a small amount of nanoparticles dried at 60 ºC for 4 hrs and to form a round disk suitable for FTIR measurements. The nanoparticles solution was prepared by dropping nanoparticles on the var-coated copper grid and air-dried (Kumar *et al.,* 2013).

TEM Analysis

The morphology and composition of the product identified by High Resolution Transmission Electron Microscopy (HR-TEM).

XRD activity

X-ray diffraction (XRD), revealed that the biosynthesis of nanoparticles are in the size range identified by nm and is crystallized in face cantered cubic symmetry. Also identified by development of nanoparticles (Lopez-Tellez *et al.,* 2013).

Anti-mycrobial study

The anti-bacterial activity was carried out by non pathogenic microorganisms like *Bacillus pumilus* and *Micrococcus luteus* by standard agar well diffusion method as per of experimental standardization. Initially 1mg/ml concentration of synthesized nanoparticles was used for antimicrobial analysis and it was further take up to only 10 µl/ml add into the well, however the clear zone of inhibition will observed under the experimental condition (Machado *et* *al.,* 2013). The sensitivity test of the used microorganisms was *Bacillus pumilus* and *Micrococcus luteus*, to the various synthesized nanoparticles will demonstrated by agar diffusion Method. A 10µl volume of each of (1mg/ml) the synthesized nanoparticles will loaded into the well using sterile pipette. The plates were kept in refrigerator for pre diffusion of the sample and incubated at 37ºc for 48 hours. Growth of the used microorganisms was *Bacillus pumilus* and *Micrococcus luteus*, was observed after the diameter of zone of inhibition and was measured subtracting the well size Penicillin and Icosonizid (10µg/ml) was used as reference standard.

MIC of the nanoparticles

The MIC of the nanoparticles was performed using the broth micro dilution assay against the selected species. Test was performed in sterile 96-well micro plates by dispensing into each well. A total volume of 200µl comprising 100µl of standardized suspension of test culture (1106 cells/ ml), 100µl of different concentration of chemical compounds which incubated up to 48 hr at 37ºC. MIC was determined by absorbance measurement at 620 nm using thermo make Automatic Ex-Micro plate Reader. The MIC was defined as the lowest concentration of the sample that inhibited the growth of test microorganism (Machado *et al.,* 2013).

Significance of the study

According to the Botanic Gardens Conservation International (BGCI) (www.bgci.org), there are about 321,212 plants present on earth. Such huge natural treasure is already present on earth as natural factories containing biochemicals (Mohammadinejad *et al.*, 2016). The exploration of the synthesis potential of nanoparticles from plant extracts demands extensive survey of plants present in various habitats. Earlier data gathered from such survey identified potent nanoparticles producing plant families like Euphorbiaceae, Moraceae, Apocynaceae (Selvakanan *et al.,* 2004). Plant extracts contain diverse chemical compounds like proteins, carbohydrates, alkaloids, tannins, Phenolics, oils, saponins which have medicinal value and the same can act as reducing and capping agents for nanoparticles synthesis. Photosynthesized NPs have many applications such as antimicrobial, biomedical, agriculture, bioinsecticides, catalyst, biosensor, dye degradation providing an eco friendly alternative to traditional hazardous compound (Wang *et al.*, 1998).

Conclusion:

Present study investigates that the synthesized NOAgNPs good antibacterial property and structural analysis also prove that the present synthesized NOAgNPs features antibacterial agent.

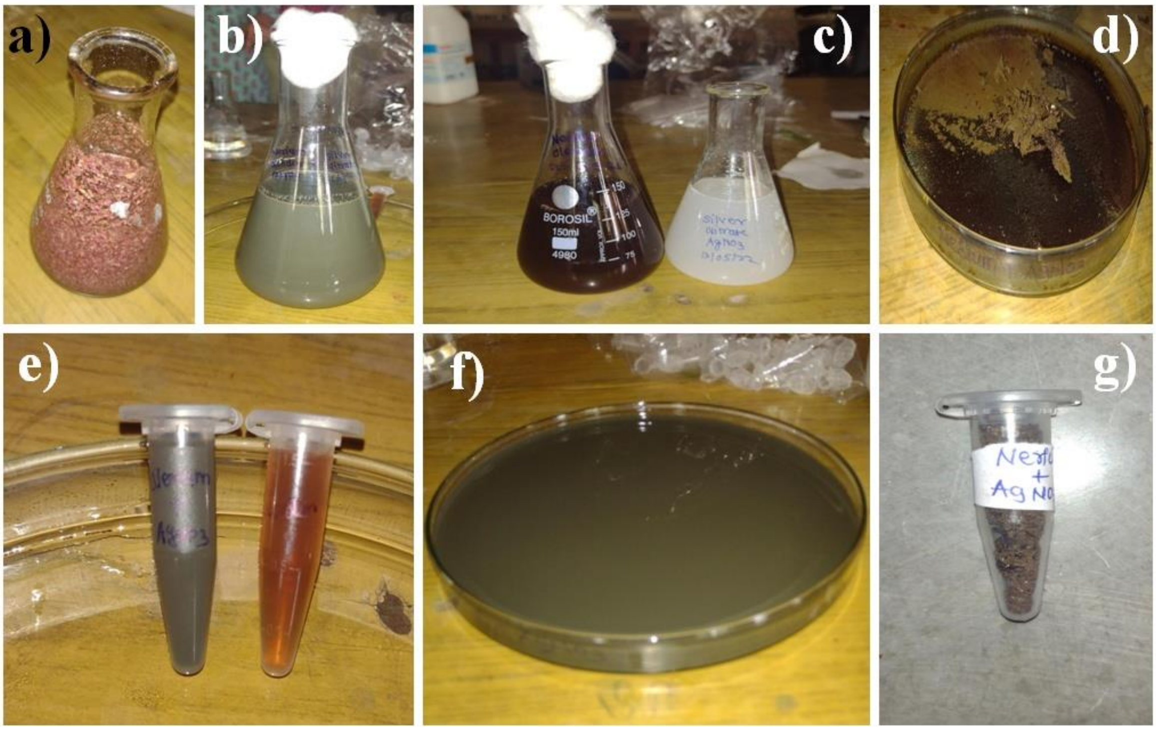

Figure 1: a) and b) *Nerium oleander* leaves mix with water and boil up to $30-40^{o}$c temperature, c) Flask 1 boil of *Nerium oleander* leaves and Flask 2 Silver Nitrate mix with water (AgNo3), d) Both 1 and 2 flask mix to each other and dry in the Petri plates, e) 1 and 2 vials containing Silver Nitrate and *Nerium oleander* leaves extract, f) Plant extract with silver nitrate solution are poured in the Petri plates, g) Developing crystal nature of NOAgNPs

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SOIL MICROFLORA AND ITS IMPORTANCE

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Abstract:

In their natural environment, plants are essential part of ecosystem which allows for wide range of microbial species in and around the soil system. It has been observed from long time to recognize the essential microbes, which influence as mycorrhizal fungi to support the soil property or nitrogen fixation to associate as symbiotic bacteria and play significant role in the plant diversity by supplying mineral nutrition. Though, the microbial diversity is associated with the characters of every plant to enhance the potential nutrition to find alternative to synthetic soil inputs which has been recently identified with unscientific method. In the current years, progress in soil science has tremendously made it possible with many innovations scientifically, in that rhizospheric microbiome reached a milestone in various dynamics. There are newer evidences that plants species structured with microbiome, exhibit most of the time in root positions and also their ecological adaptations shown with diverse places in the plants to flourish it as rhizospheric niche. In this scenario, mechanism and action of plant-microbe interactions and their driving processes are unknown phenomenon and it is need of hour study. In this chapter, our focus was mainly on the plants interaction with root association of bacterial diversity to enhance the soil mineral composition as nutrition, its summary showcase the current scientific studies, literature, knowledge, methods applied in these research fields which exhibit as convergent area to explore all the molecular mechanisms by understanding this unknown phenomenon.

Keywords: Microbiome, Nutrition, Soil, Ecosystem, Flora and Fauna

Introduction:

Soil is the naturally occurring physical covering of the earth's surface, which represents the interface of three material states: solids like (geological, deposition in bed rock and dead and decay of biomaterials), liquids (moisture and water), and gases (dry and air sacs in soil pores) (Sharma *et al.*, 2011). Any type of soil act as a unique and novel product with the combination and affinity with geological material, in the glacial, sedimentary and different geomorphological history, their presence, efficacy and various activity as biota, and relative history of diversity and with regulation. Soils are the basis source of all terrestrial forms and home to wide range of vast species diversity of archaea, algae, bacteria, fungi, insects and other major plants and animals. These soil dependents provide various biological nutrients which support for the livelihood of organisms in and above the earth surfaces. Soil also plays critical role by interacting all the organisms which inhabit the buffering, altering the product and filtering aquatic ecosystems. Therefore, soils are extremely important to human society. We depend on soils for the production of food and other resources (Dominati *et al.*, 2010) (Figure 1).

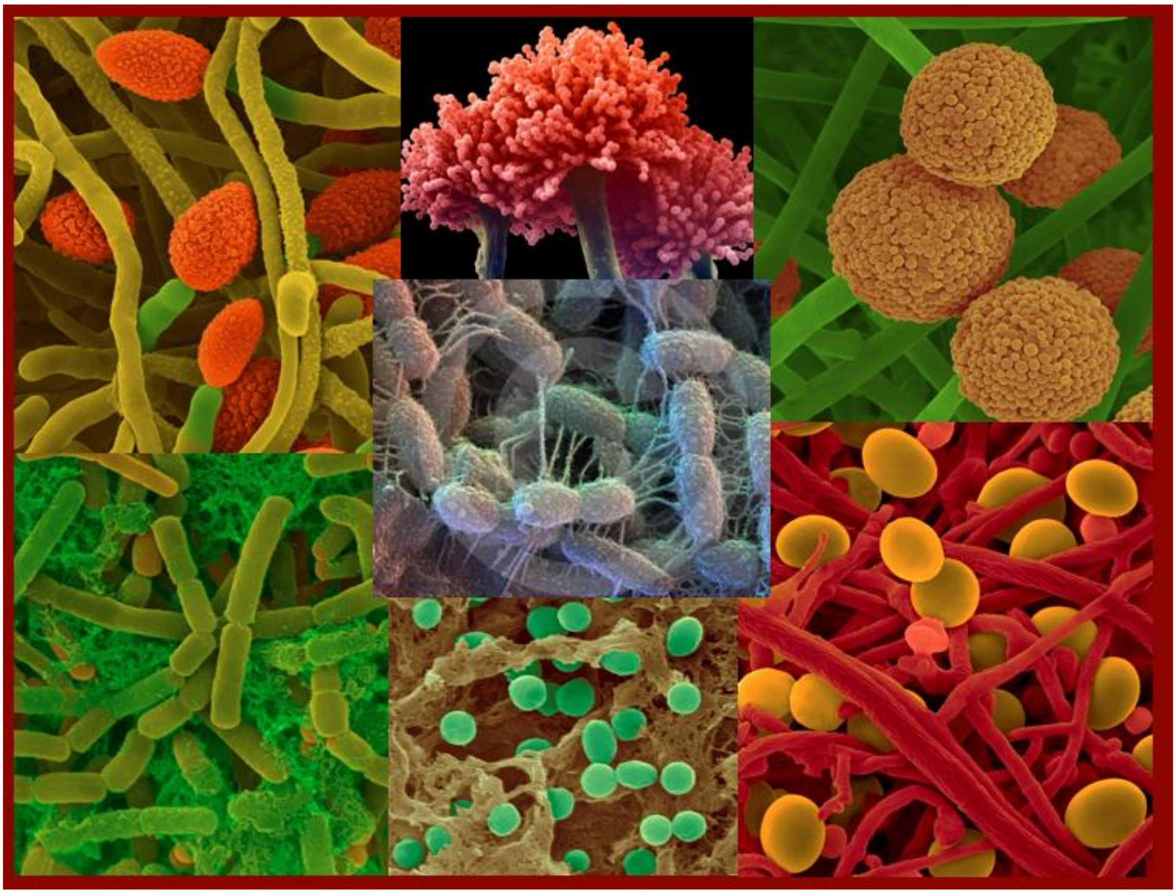

Figure 1: Various types of soil microorganisms and their morphology

Importance of soil

Soil is important to our society as it provides the foundation for most of the critical aspects of civilization. Our infrastructures, shelters, food products, agricultural activities, and wood items structured it in soil as fundamental. Terrestrial systems like forests, deserts, grasslands, and wetlands completely depended soil sources. Of course, its role is highly significant and critical for terrestrial forms on earth, which exudates majorly living creatures like animals, plants and microorganisms.

Soil plays an important role in all the natural cycles which exhibit in the earth's surface. Cycling of earth key nutrient constituents inorganic elements, they are Carbon, Nitrogen, Sulfur, Phosphorous, etc, which interact with the soil. In water cycle, soil accommodate for various reactions to mediate the rotation of precipitation within the surface of groundwater or other form of water bodies to control its storm without erosion water runs and establish it as lentic and lotic ecosystems (lakes, streams, bays, and oceans). Soil microbial diversity can interplay with environmental pollutants and help to modify it as useful constituents or destroy it by the process of degradation (Figure 2) (Fortuna, 2012).

Origin of soil and their forming factors

The genesis of soil and their fundamental factors are dependent on soil properties, it can be classified based on the ecosystem mainly climate condition, types of organisms, relief, supportive parent material and their time scale. One could say that the landscape relief, climate, and presence of organisms resulted it richness of soil environment, and responsible for many physical and chemical processes and add up thoroughly in thebase material of soil from the beginning. These factors exhibit affinities with one another, considered independently to establish useful framework and it is very thoughtful discussion in current science.

The soil may not be dead and decay material, it resulting in its property as physical, chemical and biological by the process of weathering rocks, it is a complex material of homogeneous structure which exhibit biological mass as a result of plant and animal decomposition after their end of life.

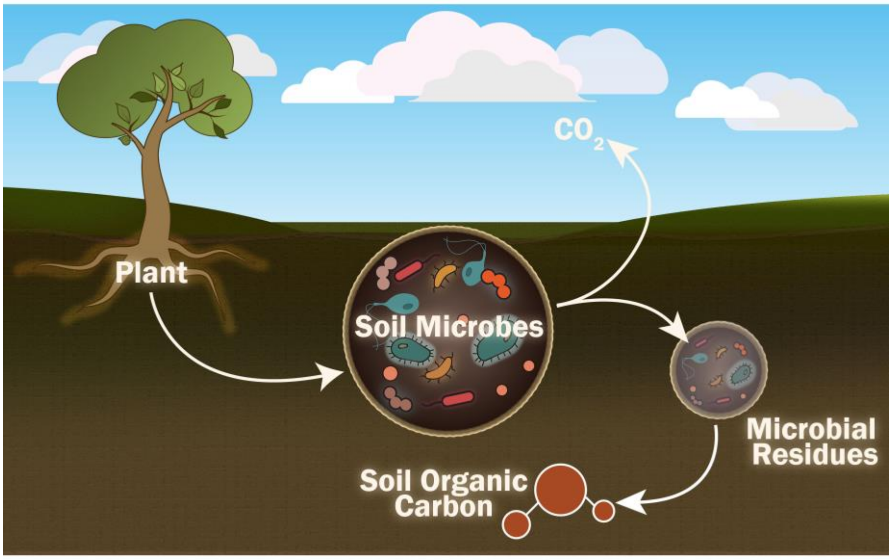

Figure 2: Soil formation with the influence of microbe and other flora

Any normal soil structure is established by solid, liquid, and gaseous elements. These elements can be classified into five major groups:

1. The mineral contents.
2. The residues of plant and animals.
3. The living creatures and their systems.
4. The aquatic components.
5. The gaseous elements.

Living systems is also plays a major role in soils (Figure 2).

Soil flora

Bacteria are very small unicellular microbes which can observe through a high resolution light (1000×) or electron microscope. They constitute the highest biomass of soil as one of the organisms. Microbes are adjacent, abundant, affinity with plant roots, due to they serve as a source of food chain. There are numerous species of bacteria in the soil but their influence is significant on agriculture crops, e.g. Rhizobium and actinomycetes. Bacteria are important in agricultural soils because they contribute to nature in the form carbon cycle to fix the decomposed biomaterial source as one of the main component for photosynthesis.

Many species of bacteria are very useful and act as decomposers, actinomycetes also best microbes effectively breakdown all the harder substances like cellulose (which are helpful in cell wall construction in plants) and harder chitin (which are useful in the cell wall production in the fungi).

Actinomycetes diversity in soil

1. These are transitional group link between microbes such as bacteria and fungi.
2. They actively degrade all the harder material of organic compounds.
3. They grow in optimal pH in alkaline condition.
4. They produce 2 important bioproducts called as antibodies namely streptomycin and geosmin.
5. Negative impact - potato scab (*Streptomyces scabies*)

Fungal diversity in soil

These organisms tend to degrade most of the waste products by the process called decomposition in all types of terrestrial ecosystems and they convert it as simple molecules like cellulose which are considered major component in the cell wall of plants.

Fungi cells exhibit microscopic structure which usually grows it longer threads called hyphae measuring in micrometres covering few diameter but also they capable to grow in higher length with the limited cells to accomplish metres in their diameter.

1. They dominate the soil diversity by producing maximum biomass.
2. They act as obligate aerobes.
3. They can survive in desiccated environment.
4. They dominate the acidic soils
5. The negative impacts of fungi in soil to cause diseases like apple replant disease (*Rhizoctonia, Pythium*, *Fusarium* and *Phytophtora*) and powdery mildew disease also caused by fungi.
6. Beneficials: *Penicillium*

Fauna as soil diversity

The soil fauna also may be characterized by the degree of presence in the soil or microhabitat utilization by different life forms. There are a many animal species which act as transient sometime, among them ladybird beetle also one, it hibernates deeper part of the soil whereas in common time lives above the stratum of plants. Gnats (Diptera) are Arthropodans which lies temporarily in the soil when they became adult come and stay above the ground. They lay their eggs in the fertile soil, then hatch it and feed them all the decomposed organic material for larvae. In the soil, most of the larvae of Dipteran exhibit as scavengers and fertile the soil. Cutworms also exhibit similar habitat temporarily in soil, their larvae fed on interested seedlings during the night. Some nematodes that parasitize insects, beetles etc., in soil by interrupt their part of life cycle or destroy them in soil. Some species like velvet mice periodically became residents in the soil to spend their life below the ground along with adults to emerge out for reproduction if required. The soil fauna exhibit as food webs with the link of aboveground systems, it is best way to make trophic to accomplish life cycle in complicated level than any other subsystem of species (Wardle *et al.,* 2004; van der Putten *et al.,* 2013). Even some of the species permanently became residents of adapted soil to establish life at various depths and environmental conditions of the soil.

In the Arthropods, collembolans are microscopic in structure and they permanently reside in soil. The external feature of the collembolan species exhibit as per the requirement of adaptive environment of the soil and it is purely specific with soil strata. Such species dwell on the litter layer in various surfaces in larger area, pigmented and utilize their long antennae as an equipment to detect the surrounding environment and possess well-developed jumping body part called furcula. Some of the collembolans live in rich mineral soils even though they are smaller, unpigmented, elongated body structure and they exhibit reduced furcula (Neher and Barbercheck, 2019).

A common classification illustrates the species specific length to determine the soil fauna as per the size and structure exhibit the classes of fauna like micro, meso, macro and mega in soil diversity. Such classification resulted in various range of soil fauna from small species to largest species (i.e., from smallest 1-2 µm as a microflagellates to largest more than 2 m of giant Australian earthworm). Measurement of body width of soil fauna is directly related to structure of their soil microhabitats. The microfauna (protozoa, rotifers, tardigrades, nematodes) inhabit water films. The mesofauna inhabit existing places as air-filled sacs or pores and they possess adaptation condition with restricted spaces in existing available spaces. The macrofauna able to create habitats by their activities in the available spaces as a burrowing creature and exhibit like megafauna, they possess maximum influences to take gross structure in soil surfaces (Lavelle and Spain, 2001; van Vliet and Hendrix, 2003). Methods for studying these faunal groups are mostly size dependent. The available macrofauna in soil is easier to collect in field levels, by hand picking and sorting, individually measured each population.

Nitrogen fixing microorganisms

Nitrogen fixation is in combined form in nature along with nitric oxide by solar energy influence in constant light and ultraviolet rays, but more amount of atmospheric nitrogen fixed it as ammonia, nitrites and nitrates in gaseous form by the soil microbes. Hence, it is occupied 90 percent of nitrogen fixation and affected by most of the soil microorganism. In nature two types of nitrogen fixation are recognized: one is free-living as non-symbiotic bacteria, covering cyanobacteria (blue-green algae) *Anabaena*, *Nostoc,* etc and second one is mutualistic as symbiotic bacteria includes the genera *Azotobacter*, *Beijerinckia*, and *Clostridium*; whereas *Rhizobium* is associated form of nitrogen fixer along with leguminous plants, and various *Azospirillum* species, associated with cereal grasses (Figure 1) (Soundarya *et al.*, 2022).

- **Example for Bacteria**: Rhizobium, Bradyrhizobium, Allorhizobium, Mesorhizobium, Sinorhizobium, Azorhizobium, Beijerinckia spp., Azotobacter, Azomonas and Derxia
- **Example for Cyanobacteria**: Anabena, Nostoc
- **Example for Actinomycetes**: Frankia

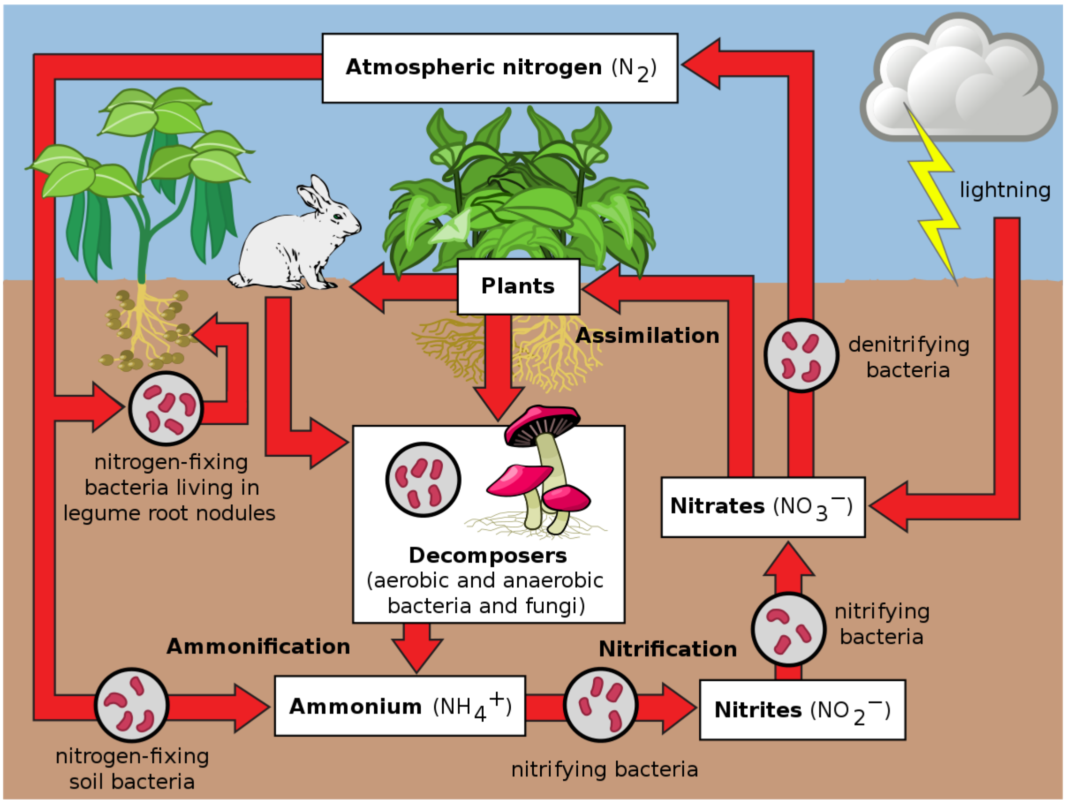

Figure 3: Schematic representation of role of soil, microorganims and their impact nitrogen fixation

Microbial interactions

Microbial interactions are crucial for a successful establishment and maintenance of a microbial population. These interactions recognized by environment with the influence of molecular approach and genetic information which include various mechanisms of actions of biomolecules. These mechanisms will influence microorganism growth to establish independently in a community, which exhibit multi-trophic level of interaction to enrich the result in higher at soil diversity. Such results establish multiple interactions in the synergistic approach of related microbes in the form of pathogenic or non-pathogenic effect in the host. In humans, the microbial diversity plays significant role in beneficial factor as protective against to diseases, due to microbial pathogens as causative agent or physiological errors in the form of disorders. Soil diversity of microbes play an a potent role in agriculture, by protecting crops, wild plants, etc, from various diseases, physiological stresses and intake of nutritional consequences (Braga *et al.*, 2016).

Microorganism interaction mainly deals with symbiotic and asymbiotic in nature in that antagonism, commensalism, competition, mutualism, parasitism, predation, roto-cooperation, syntropism, etc. are broadly classified.

Role of organisms in soil fertility

Soil fertility determined as soil's natural ability to offer sufficient quantities of the essential molecules as nutrients and adequate amount for the plant growth. There is an many opportunity improve soil fertility by the interaction of various microorganisms, as microorganisms work with regulators and act as catalysts by helping in recycling process of nutrient in any soil habitat and convert it as biological rich source with accessible inorganic elements in increasing level of fertility of soil accordingly and improvise the soil health status and due to this function cost of agriculture input reduced and maximise the growth parameters of crop to get best profits (Mohamed *et al.,* 2021). Certain gatherings increase species population of soil organisms to construct the needful amount of supplements as inorganic elements in the fertile soil, for ex., nitrogen fixing such microorganisms convert atmospheric gaseous nitrogen in the air then it is react it as solvent to form nitrogenous mixed molecules to help in the advanced characters of plant development and increasing the mycorrhizal parasites to access it free mineral supplements such as phosphorus acquiring plants. Such type of soil highly useful to organisms to form it their colony in the roots of plants, improved by quality parameters of the unfertile distinct nature of the soil and also helps in growth of the plant in advanced level due to enriching biofertilizers which continuously increasing their concentration with high priority in the utilization due to microbial inoculants in biological field like horticulture. In another approach, soil microorganisms add the various physicochemical parameters as nutrients to mix it properly as per the requirement of plant growth and development by producing hormones which promote the health of plant to increase the yield efficiency by the phytostimulators (Jacoby *et al.,* 2017). The plants always rely on microorganisms in the soil diversity to obtain their nourishment by prompting the characters as per the soil attributes by changing organic biomass deposition and various metabolic actions. Phosphorus (P) is vital key supplement in plant property and growth enhancer, and its non-availability interrupt the quality, characters and considerations their limited yields during the harvesting time in the global scenario. Although soils possess most of the area minerals, in that they have full of phosphorous, it is just required in trace level but promptly access it by plants around 75–90% of P due to accelerated metal reaction along with salts like calcium, iron, aluminium, etc to organize rapidly to get fix with surface soils. Hence, the farmers are included in agriculture activities abundant amount of synthetic fertilizers to modify the property of soil to obtain the best yield and beneficial outcome constantly. Low level utilization of P mineral is best practice to soil diversity and if more use in long-time exposure may cease the soil property and prompted it as natural contamination. Such synthetic P utilization can't be considered for the soil health and it is deteriorate the characters of plant food preparation naturally. Regardless, it is managed by microbes naturally to reduce the level of soil P compound due to that recognized as phosphate-solubilizing microorganisms (PSMs) and such P substance exhibit many negative impacts as an toxic treatment to the soil, to improve phosphorus efficiency in soil microbe role normally work it in sensible manner (Kundan and Pant, 2015).

Soil fertility evaluation by biological tests

Assessment of soil fertility becomes one of the primary objectives and to predict the able nutrient availability, their uptake depends on requirement of growing crops. It is understood that biological relationship is not direct always between the level of soil's fertility and interaction of crop with the fertility. The soil fertility is depends upon various factors under the influence of physico-chemical parameters and biological relationship to interact with one another and it is observed with the crop growth parameters during their life. Crops are the check point of biological systems to determine the soil fertility, depends upon the properties of soil structure along with their biological components, which are precursor between the nutritional status of soil to supply accurately as per the crops demand for required nutrients. If synchronization of soil and crop properties were matched, the intake and efficiency during the usage of nutritional supplements also increased significantly. This chapter provides an account of fertility assessment in the form of biological or biochemical tests which are easily analysed and tested it to know the properties of soil fertility. These evaluation tests are to the mark, well developed and more precise to know the soil fertility. In such types of cases, understand the soil biology will depends on the biochemical components, their quantitative reports on the nutrients developed and their rate of reaction during the release and intake of crop growth (Dick *et al.*, 2016).

Harmful activities of soil organisms

Bacteria: Pathogenic bacterial diversity in the fertile soil be toxic or harmful to the crop growth; outcome of the crop will be very poor due to crop health, such yield are poor and leads to crop loss. Some species of bacteria are prone to disturb the diversity and it exhibit as soil ecology imbalance, which results infertility of soil and poor performance are the impact on crops due to diseased soil health. Moreover, the presence of pathogenic bacterial diversity of soil can exhibit various types of diseases in cultivated crops and wild plants. The releasing toxic by-products might be change in the soil characters in the form of chemical parameters of soil such as pH, cation exchange ability and content of nutrients (Hermans *et al.*, 2016).

Fungi: The pathogenic fungal diversity of soil results negative impact on crops and causes various diseases, this is due to penetrating toxic element to the plant metabolism, weakened the tissue level and facing nutritional deficiency in plants. Moreover, they directly effect on the plant properties, their interactions in plant characters change the adaptive conditions and their competitive balance within the two species. Pathogens like Mycorrhiza as fungal contaminant affect the seed and seedling germination, which results in poor performance of the crop yield and harmful effect for the dynamics of plant population (Bennett and Cahill, 2016).

Virus: In soil virus community also play a harmful role in distinct proportions as an plant pathogens which reach via soil to the plant in mechanical approach like vectors (nematode or fungal). Viruses are also pathogenic to other microbes, due to that these bacteria, fungi and protozoa alter the ecology of soil by unbalancing the in the biotic and abiotic soil components. Viruses significantly affect the properties of crops due to the variation in physical and chemical parameters of soil by affecting the biotic and abiotic components of the soil (Reavy *et al.,* 2015).

Actinomycetes: These microbes also play a harmful role in the soil, resulting in that threat to the plant, animal and other microbial decreased diversity. As a pathogenic form of actinomycetes cause various plant diseases which can affect the crop health and yield loss in agriculture (Bhatti *et al.,* 2017; Sapkota *et al.,* 2020).

Protozoa: As per the literature all the soil bacterial diversity utilize the source as a food for the protozoan species and it is also observed that protozoa can harm the soil bacterial diversity. Some species of protozoan indirectly harm to the plant growth, which result in poor crop health and low yield in the agriculture (Jayapalan, 2017).

Blue-green algae: In many studies, over growth of algae form it as algal blooms, which release the toxins in the soil or in the sediment residues and affect it directly or indirectly harmful to the vegetation. The poor diversity of cyanobacteria in the soil also reduces the oxygen level and decreases the bacterial communities in the soil diversity (Chorus and Bartram, 1999; Yagya and Shreeti, 2012; Kumar *et al.,* 2015; Al-Hussney, 2022).

Nematodes: Predatory nematodes are also harmful to the soil diversity as they affecting the useful microbial diversity in the fertile soil, decreasing soil properties and the plant health. Plant and parasitic nematodes interact it for feeding of during the germination of seedling by effecting the plant roots and due to that crop loss is very common in soil specific agriculture (Freckman, 1982).

Conclusion:

It is well known that soil microflora plays a significant role in soil environment, the change in the soil physicochemical parameter lead to abnormal shape of ecosystem and their biological resources. The condition of the soil environment and its quality are very poor and deteriorating due to various types of pollution over a time in the entire world. For this reason, it is worthwhile to carry out monitoring of soil health any activity should be executed like converting it to as agricultural land in order to observe outcome of the product, how quickly and to which extent occur the quality. It is important to manage the environment sensibly so that it does not degrade and at the same time allows obtaining good production results. An additional problem is the difficulty in interpreting and comparing results of biogeochemical parameters with new methods of microbial identification (e.g., sequencing). Therefore, current work stated on the subject in current need of hour and what action should be taken to conservation of soil properties as an environmental science research.

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MICROBIAL DIVERSITY AND ITS IMPORTANCE

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Abstract:

Biodiversity is sum total of the studies on taxonomic, genetic, habitat and ecosystem characteristics of living systems. All the living individuals of a species contain a definite combination of genes and the intrinsic interactions among the gene pool influences evolution, survival and phenotypic/genotypic changes of the part of the biodiversity i.e. community. The amount of genetic diversity within population varies tremendously, as much of the modern conservation strategy is concerned with the maintenance of genetic diversity within the population of microbial, plants and animals. Germplasm, acquired from the vast biodiversity, provides a major source of biological material for the development of medicines, vaccines, pharmaceutical products, improved crop and animal varieties and for other environmental applications. Industrial revolution in any nations, which have access to technology and resources to patent and develop commercial biological products, are having the benefits of biodiversity through the collected and conserved germplasm flowing through the international research centres. In fact a particular genetic contribution usually represents only a small percentage of the total value of the eventual products.

Keywords: Biodiversity, Ecosystem, Genetics, Germplasm, Technology, Microbes

Introduction:

Microorganisms play a distinctively vital role in the functioning of the ecosystems in maintaining a sustainable environment and its productivity. The loss of biodiversity and their ability to provide ecological services to humans has now become a central thought to be considered in ecology. A number of major research works have recently revealed that dwindling floral diversity may impair the plant biomass, primary production and nutrient retention, and many other properties of the ecosystem.

At present, the interrelationship between biodiversity and ecosystem functioning in ecological and environmental sciences has emerged as a central issue. A few reasons for ignoring the management of microorganisms may be due to the fact that they are invisible, less familiar and considered primarily as disease causing agents.

However, few research studies have directly tested the consequences of changing the diversity of ecosystem components other than plants, and simultaneously manipulated the diversity of primary producers (algae) and decomposers (bacteria) in aquatic microorganisms and established a complex interactive effect of algal and bacterial diversity on algal and bacterial biomass production. Both algal and bacterial diversity had significant effects on the number of the carbon source used by bacteria, suggesting nutrient cycling associated with microbial exploitation of organic carbon source as the link between bacterial diversity and algal production. There are several explanations but the exact theory is greatly missing (Figure 1).

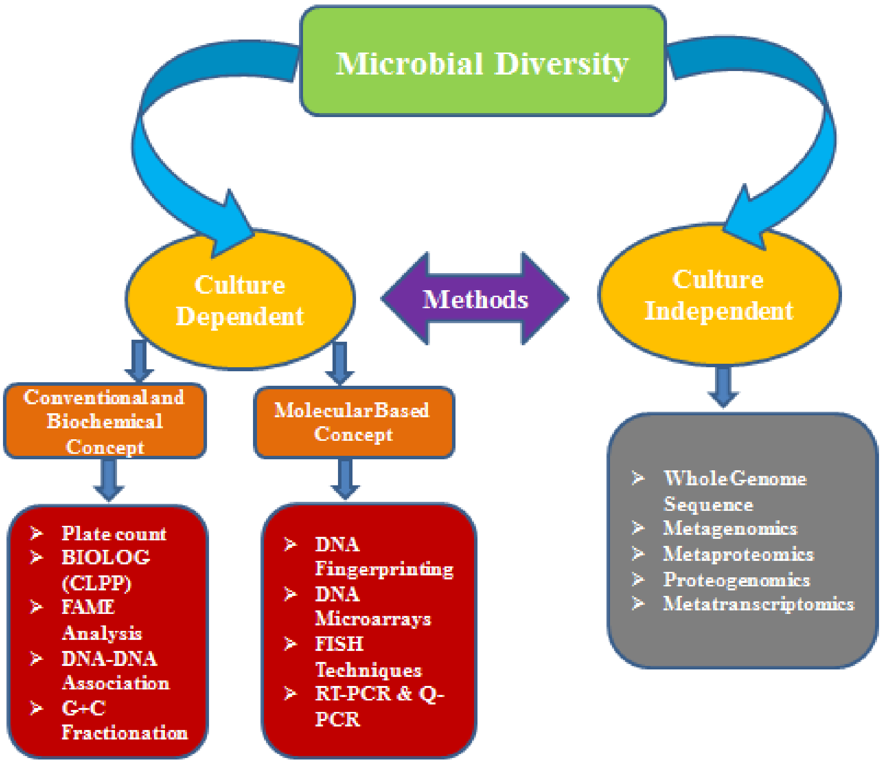

Figure 1: Characterization of Microbial Diversity Various Strategies

Necessity for conserving microbial diversity

Conservation of microbial diversity always relates to the conservation of the microbial gene pool in the ecosystem. The conservation of the physical and chemical conditions within the environment that support the indigenous microbes will connect to the conservation of the gene pool and microbial diversity. The diversity of microorganisms is critical to the functioning of the ecosystem, because there is the need to maintain ecological processes such as organic matter, nutrient cycling, soil aggregation and controlling pathogen within the ecosystem.

Extremophiles

Majority of life forms found in extreme environmental conditions are extremophilic microbes. These extreme physico-chemical conditions may be pH, heat, salinity, pressure, radiation, etc. These microbes can be characterized by using 16s r-RNA comparative sequencing technology. These microbes may be capable of producing a wide array of enzymes in extreme conditions which may be used in various industrial applications such as lipase, protease, DNA polymerase, etc (Tripati, 2007). These microorganisms hold many secrets such as genetic instructions which make them able to produce these enzymes in extreme conditions.

Causes for the decrease in biodiversity

The diversity of microscopic life forms (including viruses, archaea, bacteria, and small eukaryotic microorganism) are recently coming to light, and their varieties, abilities, distributions, ecosystem functions, and conservation status need to be further investigated. The primary cause is habitat fragmentation, degradation, and destruction due to land use, change arising from conversion, strengthening of production systems, abandonment of traditional (which were often biodiversity friendly) practices, construction, and catastrophic events including fires. There are some other key causes which include excessive exploitation of the environment, pollution, and the spread of invasive alien species (Nardini *et al.,* 2010).

Commonly used measures of biodiversity, such as the number of species present, are strongly scale dependent and only report a change after a species is lost. There is no worldwide accepted set of methods to assess biodiversity. The main problem is that the data is much diverse and it is physically discrete and disorganized. The solution is to organize the information, and create systems whereby data of different kinds, from many sources, can be pooled. This will improve our understanding of biodiversity and will allow the development of measures of its condition.

1. Consequences of anthropogenic activities

Many reports depict the effect of chemical pollutants such as polycyclic aromatic hydrocarbons (PAHs) on microbial community structure. PAHs are present in oil and coal, produced by incomplete combustion of wood and coal. They are widely spread all over the world and are considered as highly polluted, due to their toxic, carcinogenic and mutagenic effect on microorganisms. Investigations on bacterial communities in PAH's contaminated soils at an electronic waste processing sites in China reveals that various levels of PAH's might affect the bacterial communities by quell or favour certain bacterial groups, like uncultured *Clostridium sp.* and *Massilia sp.,* respectively.

2. Reef ecosystem

Anthropogenic activities such as fishing and pollution have moderately or severely degraded most of the coral reefs, hence it is very challenging to separate local from global effects. Sandin *et al.* (2008) have surveyed coral reefs on deserted islands in the Northern Line Islands to provide a baseline to reef community structure, and on increasingly populated islands to document changes due to human activities.

3. Climate change

Change in biodiversity (such as changing distribution, migration, and reproductive patterns) has an effect on climate which are observable already. By the end of 2100 the average temperature is expected to rise between 2 and 6.3°C. The predicted impact associated with such increase in temperature include further rise in global mean sea level of 9-88 cm, more precipitation in temperate regions and Southeast Asia, in turn a higher probability of floods (Nardini *et al.*, 2010). Pollution from nutrients such as nitrogen, introduction of invasive species, over harvesting of wild animals can all reduce resilience of ecosystems. In the atmosphere, greenhouse gases such as water vapour, carbon dioxide, ozone, and methane act like the glass roof of a greenhouse by trapping heat and warming the planet.

4. Influence of temperature on microbial communities

Pearce (2008) and Rodriguez Blancho *et al.* (2009) have exhibited the influence of certain factors such as temperature, nutrient availability, grazing, salinity, seasonal cycle, and carbon dioxide concentration on bacterial community structure in the polar and alpine ecosystems. The results suggest that the spatial distribution of genetic variation and, hence, comparative rates of evolution, colonization, and extinction are particularly important when considering the response of microbial communities to climate change. Although the direct effect of a change in temperature is known for very few Antarctic microorganisms, molecular and genomic techniques have given us an insight into the potential effects of climate change might be at the molecular/cellular level (Friedmann, 1993).

Applications of microbial diversity

1. Biogeochemical cycling of matter

Soil acts as the source of nutrition for the growth of a spectrum of microorganisms which have remarkable ability to degrade a vast variety of complex organic compounds due to their metabolic bioremediation agents. They also play a vital role in providing conditions for functions of humans and animals and for the continuation of all life forms on Earth. Many microorganisms carry out unique geochemical processes critical to the operation of the biosphere (Gruber and Galloway, 2008) and no geochemical cycle is carrying out without their involvement. Metabolic variation of microbes is enormous, ranging from being photo- and chemosynthetic and to degrade various anthropogenic xenobiotic compounds. Microorganisms are the primary organisms responsible for degradation of a great variety of natural organic compounds, including cellulose, hemicellulose, lignin, and chitin, which are the most abundant organic matter on Earth (Mishra and Thakur, 2012). Due to their versatility, microbes not only provide ecological services but also play a major role in semi artificial systems such as sewage treatment plants, landfills, and in toxic waste bioremediation. Few examples in which microbes are responsible for degradation of toxic chemicals derived from anthropogenic sources such as PAH, PCBs (polychlorinated biphenyls), dioxins, pesticides, etc (Davison *et al.,* 1999; Jaiswal *et al.,* 2011) (Figure 2).

Figure 2: Multi-role Microbes and their Application

2. Industrial applications of microbes

Many products useful to mankind are synthesized at commercial level using microbes. Beverages, antibiotics, alcohol, enzymes (glucose oxidase, amylase, protease, lipase, cellulose, xylanase, etc), proteins, vaccines, steroids, amino acids are the few important examples. Microbial biochemicals are also used as biocontrol agents as an alternative to insecticides, pesticides etc.

3. Biodegradation of xenobiotics

Man has been using pesticides such as BHC, DDT, 2,4-D, 2,4,5-T increasingly to get rid of unwanted weeds, insect pests, or pathogenic microorganisms. Bioremediation of the environment can be achieved easily as an ecofriendly way, by the use of microorganisms and plants to degrade xenobiotic compounds, thus decontaminating the polluted area.

Biological methods are more effective as they convert toxic chemicals to less toxic ones and possess a significant degree of self-regulation (Mishra *et al.,* 2013). Microorganisms have various capacities to biotransform and, in some cases, completely destroy toxic chemicals from our environment. Since these transformations alter the chemistry of the hazardous chemicals, they may also alter toxicity, environmental fate, and bioaccumulation potential (Das *et al.*, 2012). Several halogenated chemicals such as the chlorinated aromatic compounds, which are major contaminants, nitro aromatics and other conjugated hydrocarbons-polluted contaminated sites could be reclaimed by use of the vanguard organisms isolated from contaminated sites by enrichment cultures.

Majority of the reactions in nature result in the mineralization of the contaminant but sometime recalcitrants formed during the process act as potent toxic compound than the original xenobiotic chemical. *Pseudomonas putida* and *Burkholderia cepacia* have even been genetically engineered to cover a wider range of contaminants though *Pseudomonas sp.* possesses metabolic plasmids too. Lajoie *et al.* (1994) studied the use of surfactant based field application vectors for PCB degradation, as single microbe barely possesses all the enzymes for mineralization of a xenobiotic chemical. The specificity of the pollutant and the microbe degrading it depends upon the enzymes involved in the selective chemotaxis of the microbe toward the contaminant (Samanta *et al.*, 2000). The second phenomenon is of great interest as it increases the bioavailability of a pollutant to bacteria. As heavy metals are common contaminants worldwide and are a threat to the quality and sustainability of natural soil resource, rescuing of the heavy metal contaminated soils by microbes (*in situ* bioremediation) is a low cost and effective tool to minimize environment pollution and is in use today (Evdokimova, 2000). Biosensors and several biomarkers are now available to technically report the presence of specific contaminants at a particular site.

4. Application of microbial products in novel chemical synthesis

Bioprocesses, which involve biocatalysts for the production of useful compounds, are expected to play a key role in green chemistry. Microbial diversity constitutes an infinite pool of novel chemistry, making up a valuable source for innovative biotechnology. So far we have only scratched the surface of it. The most recent estimates suggest that by now we only know approximately 5% of the total species of fungi and may be as little as 0.1 % of the bacteria and among the ones already described, only a small fraction has been examined for metabolite profile.

The microbial secondary metabolites can be brought in use in three different ways: the bioactive molecule can be produced directly by fermentation; or the fermentation product can be used as starting material for subsequent chemical modification (derivatization); or thirdly the molecules can be used as lead compounds for a chemical synthesis. Remarkable milestone in the medicinal use of microbial metabolites and their derivatives was the introduction of the immune suppressants cyclosporin A, and rapamycin (Chen *et al.,* 1995; Van Middlesworth and Cannell 1998). Other examples are the commercialization of the antihyperlipidemic lovastatin and guggulsterone (Urizar *et al.,* 2002). Microbial natural products have also been developed as antidiabetic drugs, hormone (ion-channel or receptor) antagonists, anticancer drugs, and agricultural and pharmaceutical agents (Zhang, 2005).

Genetic diversity and metagenomics

Genetic diversity is manifested as biological diversity through the structure, organization, regulation, and expression of DNA. Presence and expression of DNA in the biological systems of a given environment determine the physiological functions of the biotic and abiotic components of the environment. Metagenomics (also referred to as environmental and community genomics) is the genomic analysis of microorganisms by direct extraction and cloning of DNA from an assemblage of microorganisms. It is a new field combining molecular biology and genetics to isolate, identify, and characterize the genetic material from environmental samples and express it in suitable host. The metagenomic DNA is inserted into a model organism that lacks a specific gene function. Restoration of a physical or chemical phenotype can then be used to detect genes of interest. A genotype is the specific sequence of the DNA and offers another means of analyzing the metagenomic DNA fragment. The sequences of the bases in DNA can be compared to the database of known DNA to get information regarding the structure and organization of the metagenomic DNA. Comparisons of these sequences can provide insight into how the gene proteins function of the diverse microorganisms (Figure 3).

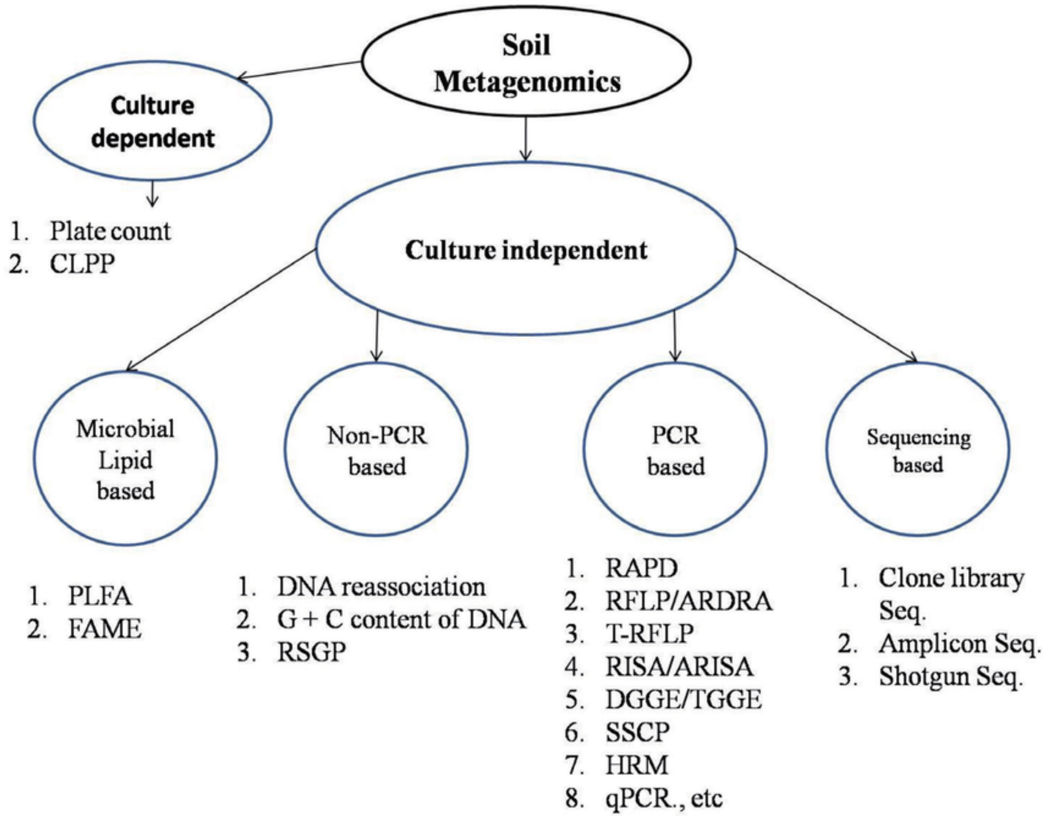

Figure 3: Advanced Methods for Characterization Microbial Diversity

Analysis of microbial diversity

1. Conventional and biochemical methods

Conventional and biochemical methods are of high significance in the study of microbial diversity. This can be described using physiological diversity measures too, which avoid the difficulties that may arise in grouping of similar bacteria into species or equivalents. These measures include various indices (tolerance, nutrition, etc.). Multivariate data analyses have also been used for extracting relevant information in the large data-sets frequently obtained in diversity studies.

a. Plate counts

Plate count is the traditional method for the assessment of microbial diversity is selective and differential plating and subsequent viable counts. Being fast and inexpensive, these methods provide information about active and culturing heterotrophic segment of the microbial population. There are many limiting factors in this assessment method including the difficulties in removing bacteria or spores from soil particles or biofilms, selecting suitable growth media (Tabacchioni *et al.*, 2000), maintenance of specific growth conditions (temperature, pH, light), inability to culture a large number of bacterial (Barnes *et al.*, 1994) and fungal species using techniques available at present, and the potential for inhibition or spreading of colonies other than that of interest (Trevors, 1998).

b. Sole carbon source utilization (SCSU)

Biochemical identification systems (such as API and Biolog), the sole carbon source utilization (SCSU) system, also known as community level physiological profiling (CLPP) system was introduced by Garland and Mills (1991). Initially this was developed as a tool for the identification of pure cultures of bacteria in the species level, based upon a broad survey of their metabolic properties. The functional capability of the microbial population is examined by SCSU, and the resulting data is analyzed using multivariate techniques to compare metabolic capabilities of communities (Preston- Mafham *et al.,* 2002). However, as microbial communities are composed of both fast and slow growing organisms, the slow growers may not be included in this analysis. Growth on secondary metabolites may also occur during incubation.

c. Phospholipid fatty acid (PLFA) analysis

The fatty acid composition of microorganisms has been used extensively applied in characterizing microorganisms. Taxonomically, fatty acids in the range C2–C24 have provided the greatest information and are present across a diverse range of microorganisms (Banowetz *et al.,* 2006). The fatty acid composition is stable and is independent of plasmids, mutations, or damaged cells. The method is quantitative, cheap, robust and with high reproducibility. However, it is important to notice that the bacterial growth conditions are reflected in the fatty acid pattern. This method is also known as the fatty acid methyl ester (FAME) analysis.

Molecular techniques for studying microbial biodiversity

Efforts are very much needed for the conservation of microbial diversity. The extent of microbial diversity is still not known exactly. In spite of this fingerprinting patterns denaturing gradient gel electrophoresis (DGGE), single strand conformation polymorphism (SSCP) depicts the microbial ecosystem and maintains biodiversity data (Loisel *et al.,* 2006). Ehrlich and Wilson 1991 are of the opinion that astonishingly small amount of research is devoted to bacterial diversity, in comparison to genetics and molecular biology of select species. Newer techniques allow environmental screening for the presence of nucleic acids within the environmental samples. Novel molecular techniques thus allow the screening of culturable and non-culturable organisms. Non-culturable microorganisms cannot be identified by standard means. Some researchers have extracted DNA directly from samples, then used the polymerase chain reaction (PCR) to amplify small subunit ribosomal RNA (rRNA) genes, selectively amplifying those found in archaea and eukaryotes. Some of the techniques used for the studying the microbial biodiversity are RAPD, RFLP, DNA-DNA hybridization, FAME. Certain submicroscopic particles such as viruses can be studied by nonmolecular methods such as Transmission Electron Microscopy and Epifluorescent microscopy. The development of the improved methods for the isolation and characterization of viruses in the marine environment makes it possible to study their role in the ecosystem.

Conservation of microbial diversity

The biggest problem in biodiversity is a conservation of diversity; it is the resolution of conflict between man and organisms inhabiting various environments. The Conservation of biodiversity is mainly carried out by two methods: *Ex Situ* conservation and *In Situ* conservation. The United Nations Conference on Environment and Development (UNCED) process has greatly helped in placing the loss of biodiversity and its conservation as global agenda. To give momentum to such conservation of biodiversity worldwide, the Convention on Biological Diversity (CBD) treaty emerged from the Earth Summit at Rio De Janerio in June 1992.

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PLANT ECOLOGY: AN OVERVIEW

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Introduction:

Ecology is the science of relations between organisms and their environment. It is one of the important and developing branches of life science or biology. This branch of life science has gained lot of importance during last 20 to 30 years, because it deals with environment problems related to human survival and the conservation of natural resources. Ecology has been divided into two artificial branches, for the sake of convenience, as animal ecology and plant ecology. The plant ecology deals with the relationship between plants and their environment.

The term plant ecology is coined from Greek word Oikology (Oikos-Home, logos-study) i.e. study of plants as they exist in their natural homes or habitat. Plant ecology, therefore, can be defined as study of plants in relation to their habitat. The term habitat means the sum total of all the conditions of environment, which affect the growth and development in an individual or in a plant community, in particular locality. The environment is therefore, the most important factor for studying the different aspects of palnt ecology.

The environment means surrounding. Any condition, force or a substance, in the surrounding which affects the growth and development in an individual or in plant population or plant community, therefore, becomes an environmental factor. Generally the term population is used for a group of individuals of the same species. The term community is used for natural grouping of several species populations. The effects of different environmental factors on the growth and development in the plants forming population or community, is one of the important aspects of plant ecology.

The relationaship of the organisms with their environment can be studied by considereing the effect of a particular component (climatic, edaphic and water) of the environment on an individual or a group of individuals. Ecology therefore deals with the effect of environmental factors on individuals or on populations or on communities of plants.

The branch of plant ecology known as population ecology deals with different aspects of plant population like density, natality, mortality and the effects of different environmental factors on the growth and development of plant population. The branch of plant ecology known as community ecology deals with form, structure and characters of plant communities.

The ecosystem is a complex interacting system of communities and their physical environment. Each ecosystem consists of two major components a) the biotic component, comprising all living organisms and b) the abiotic component which includes all non living components of the ecosystem exhibit, definite structural organization and definite interactions with each other. The interaction include energy flow within the ecosystem and activities of the components at different trophic levels.

Plants growing under different environmental condition exhibit different adaptation. These adaptation are due to effect of environmental factors and are essential for proper growth and development in palnts. Similarly plant communities also exhibit certain changes in their growth pattern and development, as per the changes in the surrounding. In case of communities such changes are essential to attain the climax stage of development under particular environment.

Some plants grow under specific environmental conditions and these plants are therefore useful as indicators of those conditions. Such plants are useful in environmental monitoring in particular region. To understand the effects of different envirironmental factors on individual plant or on population or on the communities of plants, it is essential to know the nature of the physical environment as well as the nature of different environemtal factors.

Climatic Factors:

The term atmosphere is used for the gaseous envelope (air) surrounding the earth while the term weather describes the general condition of the atmosphere at a particular time and place with regards to temperature, moisture and cloudness etc. Climate is term used to indicate the general weather conditions of a region, as determined by the temperature and meteorological (atmosphere) changes over a period of years. The environmental factors having origin in the climate or which determine the climate are considered as climatic factors. The important climatic factors are a) Light 2) Temperature 3) Humidity 4) Wind 5) Rainfall

1) Light: Light is one of the most important factors essential for proper growth in plants and development of vegetation. In any ecosystem the green plants are the only producers, as they can fix and convert light energy into chemical energy, in the form of different types of food molecules. In this energy fixing process, the sun is the only source of energy for the plants. The word sunlight is commonly used for solar radiation, which is in the form of rays from sun, reaching the earths surface. The solar rays are electromagnetic waves and exhibit spectrum with three main regions- ultraviolet, visible and infra-red. The term light is used for the region in the electromagnetic spectrum visible to human eye. For the growth of plant and vegetation, the light in the visible to human eye. For the growth of plant and vegetation, the light in the visible spectrum region, is important, because the energy from this part is mainly absorbed or fixed by the plants and utilized for various physiological processes.

The effect of light is exerted upon plants by change in its quality, direction intensity or duration. Differences in latitude, altitude and climate cause variations in light. In nature there is no much difference in the quality of light in various habitats. But under certain conditions e. g. thick forest, the change in light quality is due to differentaial absorption and reflection of light by leaves at different heights on the plants. Light which reaches forest floor by filtering through or between the crown of trees or by reflection from the leaves and twigs, is utilized by the ground flora for physiological functions. Even under such conditions, the light which reaches the ground is approximately normal light with various essential wavelength to produce normal growth in plants. Therefore, under normal conditions, the thick forests show rich ground flora.

The duration of light i.e. length of daylight produces very important effects such as rate of development flowering fruiting and the distribution of pants. The effect of duration of light is called photoperiodic effect. The photoperiodic requirements of plants are different in different regions and geographical distribution of plants is mainly governed by this factor.

The action of light is comparatively uniform over wide areas and therefore, the general characters of plant communities are usually not much affected by light. For individual plant light is an ecological factor, as well as physiological factor and therefore, shows direct as well as indirect effect on the growth of the plant. From ecological point of view, individual plant shows particular internal structure which is modified by the amount and intensity of light the palnt receives. Most of the plants under natural conditions, have definite requirements of light, for normal growth and developments. Some plants grow very well in direct and bright sunlight with full intensity, some plant grow very well in moderate sunlight with relatively less intensity while some plants require shade with diffuse light with low intensity. As per these ecological requirements of light, the palnts are classified into two groups a) Heliophytes and b) Sciophytes.

a) Heliophytes: The heliophytes are the plants whch can tolerate and grow in full bright sunlight. The sciophytes are called shade loving plants and these plants require sufficient shade and moderate to low light intensity for proper growth and development.

The heliophytes or sun plants show,

1. Root system with many branched roots.

2. Stem woody with short internodes.
3. Leaves with thick cuticle, well developed palisade less amount of spongy tissue in mesophyll and the cells with less chlorophyll content.
4. In aerial organs, xylem with thick rays.
5. Tissue with smaller intercellular spces.
6. Mechanical tissue more and well developed.
7. Transpiration and respiration rates relatively high, so show in general many xerophytic characters.

b) Sciophytes: The sciophytes or shade loving plants exhibit.

1. Stem relatively tall, with elongated internodes and many branches.
2. Dark green coloured leaves due to high chlorophyll contents.
3. Leaves thin with one or two layers of palisade only on upper side.
4. The leaf mesophyull loosely arranged and with more spongy parenchyma.
5. Outline or leaf margin generally entire.
6. Epidermal cells in the aerial organs with purple colored pigment i.e. anthocynin.
7. General nature of the plant is soft, herbaceous.
8. Mechanical tissues less.

2) Temperature: For growth and development in plants, the atmospheric temperature is like water in its action, because like water it is also related with each and every function in the metabolism. But the important difference between water and temperature is water is involved in the metabolic reaction as a material while temperature is related with metabolic functions as a working condition. All the metabolic reactions in the plant body are dependent, directly or indirectly on the atmospheric temperature and they are accelerated by its increase upto certain optimum limit. The temperature affects the development in both, the individual plant as well as vegetation. This effect is very distinct if we campare the vegetation in arctic or polar region, with the vegetation in desert region or with the vegetation in the equatorial forest regions.

The habitat plays an important role in determining the effect of temperature upon each species. Every plant species gets accustomed for many generation to certain extremes of heat and cold as well as seasonal variations in the temperature. The temperatures beyond these extremes check the activities in plants. Though the plant system is adapted to very wide range of temperature every plant specie scan tolerate only certain extremes of high temperature and low temperature. The adjustments to the temperature between these two extremes, becomes an important character in the protoplasm of the species and temperature tolerance becomes a fixed habit of a species. It si the tolerance capacity of a species for the temperature.

Many plants are very sensitive to temperature. The exposure to temperature beyond the tolerance capacity of a plant is inurious to its protoplasmic system. Under such conditions, both, very low and very high, temperature produce injurious or harmful effects in plants. The palnts at high altitude generally show some adaptations to low temperature injury in the form of harness is more than in summer. The injuries due to high temperature are more inurious because high temperature affects important processes like photosynthesis, respiration and sometimes kills the protoplasmic system. Therefore, the plants whch are exposed to high temperature under natural conditions show many adaptation to avoid the harmful effects. The important adaptations in such plants are-

a. High rate of transpiration to cool the aerial organs to some extent.
b. Leaves remain parallel or in vertical position instead of at right angle to sun rays.
c. White coating on the surface of leaves and other aerial organs to reflect some of the light rays due to which less amont of light energy is absorbed and the internal temperature of the organs is not allowed to increase.
d. Thick coating of dead hairs on th surface of leaves and young aerial organs, which protects the inner living cells from photo-oxidation.
e. Thick bark is formed on the surface of the stem and branches which protects inner phloem and cambium form temperature.
f. Cells are with protoplasmic system with low moisture content.

On the basis of temperature tolerance capacity of the plants the vegetation can be divide into four categories.

a. Megatherms: Plants which require relatively warm habitat or high temperature throughout the year for proper development e. g. desert plants and many tropical plants.

b. Mesotherms: These plants can tolerate low temperature during some period of the year such as winter months and during remaining period require moderate to high temperature e.g. tropical and subtropical plants.

c. Microtherms: These plants growing at high altitude and under temperate conditions, require much low temperature for their growth and development, during most part of the year. These plants cannot tolerate high temperature even for few months like summer season e.g. most of the plants at high altitude and in temperate regions.

d. Hekistotherms: These plants are restricted to regions having earth surface covered with snow during most of the part of the year i.e. in arctic regions and alpine regions (above 16,000 feet in tropical area and 12,000 feet in temperate area). These plants require very low temperature for their growth and can tolerate extremely low temperature without any injury. In the temperate regions, these plants show some adaptations to short summer season e.g. all plants in the regions covered with snow fall.

3) Humidity: In the atmosphere, water is found in the form of vapour. The total quantity of water vapour retained in the atmosphere depends on the atmospheric temperature and wind currents. The amount of water vapour increases in the atmospehere when the temperature of water vapour increases in the atmosphere when the temperature increases and the preassure decreases. At certain temperature and pressure, the atmosphere becomes fully saturated with water vapour. This condition is called saturation point. At saturation point stage, if the atmospheric is lowered down, the water holding capacity of the atmosphere reduces. This causes the condensation of water vapour in the form of rain drops, dewdrops, frost, sleet and snow etc. This process is called precipitation. So the precipitation is the main cause of rains.

For precipitation, sufficient humidity in the atmosphere is essential. The percentage of water vapour present in the air at certain temperature is the absolute humidity. The amount of water vapour required to reach the saturation point under constant physical conditions, is called relative humidity. So sufficient atmospheric humidity is essential for precipitation, which is the cause of rainfall. For this reason both precipitation and atmospheric humidty are considered together, as single climatic factor.

The atmospheric humidity affects the structure and development in plants because of its control over the process of transpiration. When atmospereic humidity is less, transpiration is more and when it is high, transpiration is less. The relative humidity helps to saturate more water vapour in the atmosphere and it is very useful to many plants. Many epiphytes like mosses, lichens and orchids etc. utilize the water vapour in the atmosphere for their growth. This moisture also helps the generation of spores in many fungi and algae.

4) Wind: Wind is the important climatic factor, which affects the structure as well as distribution of plants. The effects of wind on the plants or plant communities is either a direct effect or an indirect effect. The direct effect is the action of wind on the plant or plant community itself while the indirect effect is in the form of action of wind on the other climatic factors affecting plants.

Wind is the general term for any natural movement of air. This movement may be with high or low velocity and with great or little force. FThe movement of air is generally parallel to earth surface and therefore, it is considered as blowing of wind. This blowing wind as per its direction, velocity and fdorce, affects the plants or vegetation in different ways. Some of these affects are useful to the plants and vegetation while some effects are harmful and destructive. Some of the important effects of wind on plants or vegetation are as fallows.

A) Useful effects of wind

1. Wind is an important agent for dispersal of pollen grains, seeds and spores. The dispersal of pollen grains helps the plants in pollination. The dispersal of seeds and fruits is responsible also for the dispersal of the species to the wider area. Such dispersal is useful for increasing the chances of survival of the seedlings and evolution in the species.
2. Water logged soil is injurious to root system of plants. For proper growth of roots, sufficient air in the soil is essential. The proper aeration to roots is possible only when water logged soil dries. This drying of soil is carried out by the blowing wind by removing away moist air near the surface of soil.
3. In some regions, under certain condition, atmosphere surrounding the plant becomes very dry. Such condition increases the loss of water from the plant. The wind blowing towards the plant brings moist air from some other regions and it helps to increase the moisture contents of the dry atmosphere. This helps to decrease the loss of water from the plant by decresing the rate of transpiration. The change in the nature of atmosphere from dry to moist promote the growth in mesophytes.

B) Harmful and estructive effects of Wind

1. Blowing wind generally increases the rate of transpiration by removing the air satureate with water from the leaf surface, and by bringing dry air in that region. With dry air the rate of transpiration incresees, as more and more water dufuses out through stomata from the intercellular speces in the leaves.
2. The strong wind with great force is of destructive nature. Under certain conditions it is responsibnle for soil erosion and complete destruction of the vegetation in the region. This effect of wind is responsible for development of barren lands.
3. When wind blows with great velocity and force, it is responsible for uprooting of the tall, large trees in its path. Such wind is also responsible for lodging injriesw in the crop plants like wheat, rice and jowar etc. Due to unidirectional force of wing the annual herbaceous erect crop plants in the field bend, break and fall on the ground. This injury which is responsible for lodging of crop plants is called lodging injury. This type of wind is also responsible for premature fruit fall in many trees.

4. In places with very warm summer season, dry and hot winds burn young parts including growing terminal and dormant axillary buds. The buds dry and fall on the ground. This affects the growth in the trees in these regions.

To avoid the harmful effects of wind on the crop plants and existing vegetation, in certain regions, trees like *Casurina*, *Eucalyptus* and *Acasia* etc. are planted in the form of thick wall like plantations. These tree plantation serve as wind break and help to reduce soil erosion, evaporation, transpiration and other harmful effects of wind.

5) Rainfall: Precipitation is the main source of water. Precipitation occurs in different forms such as drizzles, rain, snow, dew, frost, sleet and hail. Drizzles are the minute water droplets floating in air. Rain is the drops of liquid water, snow referes to the solid form of moisture, dew and frost are formed due to condensation of moisture directly on surface of objects, soil, plants and animals. Small pellets or grains of ice are the sleets while hails are the balls or lumps of ice.

On global scale mean actual rainfall is 85.7 cm. Out of the total rainfall 23 % is received by land and 77 % by oceans. The atomosphere is receive 16 % of water from land and 84 % water from oceans in the form of water vapours. 70 % of earth surface is occupied by water. It is present in the form of water reservoirs like oceans, sea, rivers and lakes.

Water is universal solvent and is essential for life because all the metabolic processes of living organisms takes place in the medium of water. Being universal solvent nutrients enter in the plant body in dissolved condition through water. Thus water helps in nutrient absorption. As an essential constituent of photosynthesis water is needed in the manufacture of carbohydrates. Protoplasm whch is basis of life is mostly made up of water.

Edaphic Factors:

The study of soil science is called Pedology (Pedos-soil). Soil is one of the most important ecological factors. Soil is the natural habitat for plants, animals and microbes. Soil is the outermost layer of earths crust. It supports the vegetation and supplies them minerals, water and also give shelter to other living organisms.

The soil is usually defined as any part of the earths crust in which kplant root penerrates. The soil environment is dynamic and complex. Due to its complex nature. Soil is definedas Weathered surface of the earths crust which is mixed with organic material in which microorganisms live and the plants grow.

The soil environment is composed of inorganic materials, organic matter (i.e. humus), soil water, soil air, soil fauna and soil flora. The soil is essential for successful growth of the plants. The soil factor is primarily responsible for the local distribution of vegetation found within the same climatic regions.

Soil Formation:

The different processes that are involved in soil formation include laterization, melanization, podsolization and gleization are as follows.

1. Laterization: In tropical areas due to high temperature and high rainfall silicate minerals are leached in the form of silicic acid and there is accumulation of sesquioxides of aluminium and iron in the soil. This accumulation of these sesquioxides is called laterization.

2. Melanization: This process is very common in the areas with low humidity. In this process the humus formed in upper horizons get mixed in 'A' horizon along with water. Due to melanization 'A' horizon becomes dark coloured.

3. Podsolization: This process generally occurs in the temperate regions receiving moderate rainfall. These regions shows conifers and members of family Ericaceae as chief vegetation. The litter produced by these plants is rich in phenolic (acidic) compounds. The phenolic (acidic) compounds inhibit microbial activities. The water percolating through this acidic litter being acidic dissolves minerals and humus content from 'A' horizon. The leached minerals and humus get accumulated in the 'B' horizon in the form of hard, distinct layer. Due to loss of chemicals the 'A' horizon becomes light as coloured. This processis called podsolization. The soil developed by this process is termed as Podsol.

4. Gleization: Under water logging conditions the rate of organic matter decomposition is very low as well as these soils become blue-grey or grey coloured due to the accumulation of ferrous compounds in the soil. Due to these reasons there is accumulation of a sticky, compact layer of blue-grey or grey colour at the bottom of 'B' horizon. This process is known as gleization and the soil formed by gleization is termed as 'Gleys'.

Soil Profile:

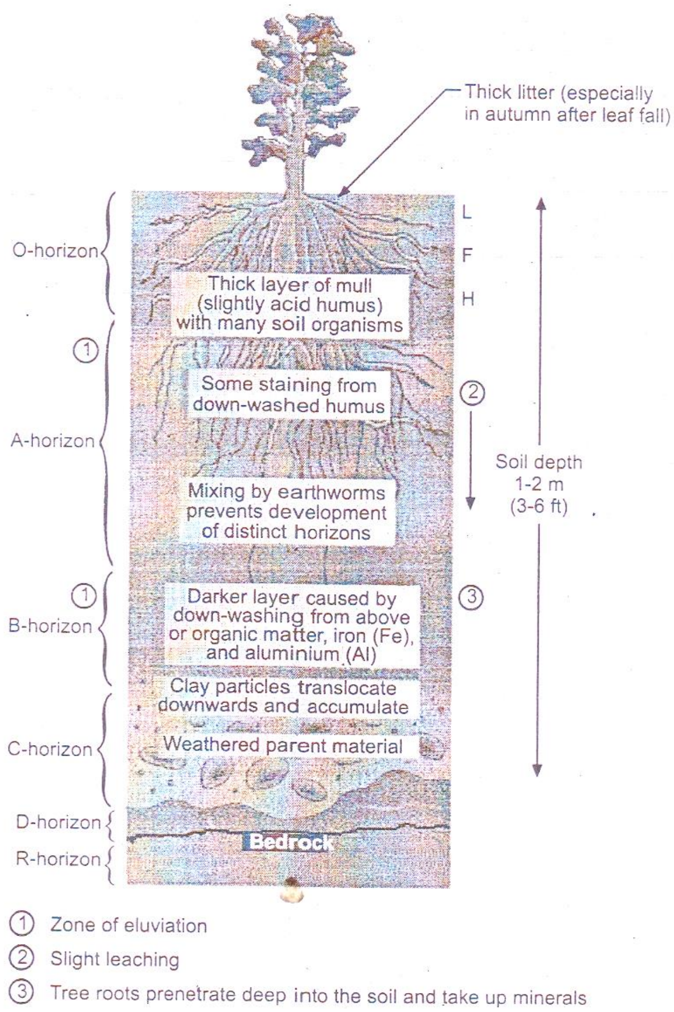
As the process of pedogenesis is influenced by different factors, different types of soils are formed. The different types of soilsare described and identified by reference to their profiles. Soil profile is the vertical section of soil showing various superimposed horizons or layers. Each layer has different structute, thickness, consistency, texture, porosity, color and chemical composition. Soil profile changes from place to place and it is influenced by parent rock, vegetation and climate. Soil profile shows six different horizons which are designated as O-horizon (organic horizon or litter zone), A-horizon (top soil), B-horizon (sub-soil), C-horizon (weathering rock), D-horizon (weathering rock), and R-horizon (bed rock). The different layers in soil profile can be described as fallows.

1. O-horizon (organic horizon or litter zone): This is the topmost layer of earth's crust. It is generally found in forest but absent in desert, grassland and cultivated land. It is composed of fresh or partially decomposed organic matter. This horizon is rich in saprophytic fungi, bacteria and protozoa.

2. A-horizon (top soil): It is a top soil zone. It is also called as leaching or eluviation zone. This zone is subdivided into two zones such as A_1 and A_2.

i. A_1 horizon: This layer is dark coloured and rich in humus, mineral soil, bacteria and fungi. It is also designated as humic or melanized region.

ii. A_2 horizon: This layer is light in color and contains less humus. This is a zone of maximum leaching hence from this zone silicate, clay, iron oxide, aluminium oxides and organic chemicals are lost downward during rainfall making this zone light coloured.



Soil Profile

3. B-horizon (sub-soil): This horizon is present below the 'A' horizon. It is divided into B_1 B_2 B_3 sub-zones depending on the stages of soil development in the region. This is also called as zone of illuviation (collection of materials) because the chemical compounds leached from A_2 region get collected in this zone. It is dark coloured and coarse textured due to the presence of silica rich clay, hydrated oxides of alumminium and iron as well as organic colloids. Roots of shrubs and trees reach up to this horizon.

4. C-horizon: This is thick and contains large masses of partially weathered minerals materials.

5. D-horizon: This layer shows presence of rocks in active weathering state.

6. R-horizon (Bed rock): This is the lowermost layer of unweathered parental rock. It is hard and on this layer percolating gravitational water gets collected.

Classification of Soil: There are different systems of soil classification. On the basis of manner of soil formation they are classified into the following types.

i. Residual soils: In these soils the complete process of soil formation i.e. weathering and pedogenesis occurs at the same place i.e. parental rock.

ii. Transported soils: In these type of soils, weathered parental rock material is transported away from their place of weathering by various agencies anf then process of pedogenesis occurs. Based on the involvement of agents in transportation the transported soils asre sub-classified as:

a. Alluvial: Soil transported by river or running water.

b. Colluvial: Soil transported by gravity.

c. Glacial: Soil transported by ice or glaciers.

d. Eolian: Soil transported by wind.

Chemical Properties of Soil: Chemical properties of soil includes soil composition, soil p^H, cation exchange capacity (CEC), soil enzymes and soil humus.

1. Soil Composition: Chemical composition consists of both organic and inorganic compounds. Inorganic compounds include mainly Ca, Mg, Fe, Al, Si, Na, K and trace of Mn, Zn, Co, I and Cu. It influences the p^H of soil. Organic compounds found in soil are of different types such as proteins, amino acids, aromatic compounds, purine, pyridines, sugar, alcohol, fats, oils, resins, waxes and lignin. These organic compounds are derived from dead remains of plants and animals. Organic matter and humus form the organic growth and type of vegetations.

2. Soil Reaction (Soil p^H): p^H is defined as negative logarithm of hydrogen ion concentration. It is a measure of the active hydrogen ion (H^+) concentration. It is an indication of the acidity or alkalinity of a soil, and also known as soil reaction. The p^H scale ranges from 0 to 14, with values below 7.0 acidic, and values above 7.0 alkaline. A p^H value of 7 is considered neutral. A p^H

range of 6.0 to 6.8 is ideal for most crops because it conincides with optimum solubility of the most important plant nutrients.

Soil pH ranges between 2.00 to 10.5. Some soils are acidic and some are alkaline. Soil pH is influenced by mineral content, climatic, weathering and rainfall. Soil pH determines the vegetation type of an area, for example Sal grows at pH 4.5 to 5.5 while Teak requires a p^H of 6.5 to 7.6. Warm and dry climate soils are strongly basic. The acidic soils occur in high rainfall regions like Western ghats, Kerala and Assam. The soil pH affects the availability of nutrients andf minerals. Some minor elements (i.e. iron) and most heavy metals are more soluble at lower pH. In acid soils, hydrogen and aluminium ar ethe dominant exchangeable cations. Increase in pH increase calcium availability. Nitrogen is available ast 6 to 8 pH. The soil pH affects the microbial activity in the soil. Below pH 5 fungal anfd bacterial activities are reduced. Hence lowering the soil pH below 5 may be helpful to control the soil borne diseases like root rot of cotton, root rot of tobacco and potato scab while club rot of crucifers and Rhizoctonia root rot can be controlled by increasing the soil pH.

3. Cation Exchange Capacity (CEC): Ability of the soil particles to adsorb and exchange cations that are loosely bound to its surface is called cation exchange capacity (CEC).

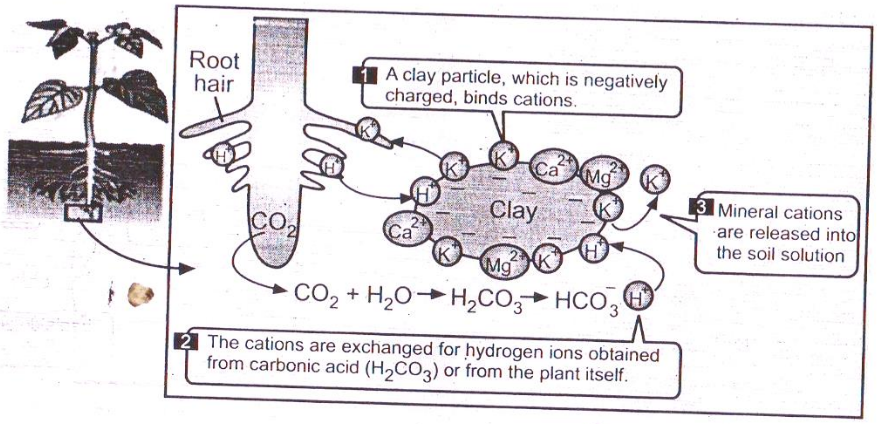
Some plant nutrients and metals exist as positively charged inons, or 'cations' in the soil environment. Among the more common cations found in soils are hydrogen (H^+), aluminium (Al^+), calcium (Ca^+), magnesium (Mg^+) and potassium (K^+). Most heavy metals also exist as cations in the soil environment. Cation exchange capacity is highly dependent on soil texture and organic matter content. Clay and organic matter particles are predominantly negatively change (anions), and have the ability to hold cations from being leached or washed away. The adsorbed cations are subjected to replacement by other cations in a rapid, reversible process called cations exchange. Organic matter has both (+) and (-) sites.

Cations leaving the exchange sites enter the soil solution, where they can be taken up by plants, react with other soil constituents, or be carried away with drainage water. The soil having more percentage of clay and organinc matter shows higher CEC.

4. Soil Enzymes: There are 50 enzymes in various types of soil. The main source of soil enzymes are microorganisms, soil animals/insects and plant roots. These enzymes catalyse biological reactions in the soil, maintain soil fertility and support plant life. Common enzymes that are found in soil are amylase that are found in soil are amylases (wheat roots) catalases, invertases, dehydrogenases, phenol oxidases, glycerophosphatases and urease (earthworm) etc.

Salines soils have high activity of ureases while the activity of dehydrogenase is highest in forest soil and absent in alkali soils.

5. Soil Humus: Humus is a dark colored complex organic substance resulting from the disintegration of dead remains of plants and animals. The process of humus formation is called humification. It is formed either naturally or from composting. Depending on the level of decomposition humus can be classified into mor, moder and mull.



Cation Exchange Capacity (CEC) of soil

a. Mor: It is the least decomposed humus. It shows low biological activity in soil. Coniferous forest soil litter of large thickness is present. C/N ratio is more than 20 and p^H is acidic.

b. Moder: It is a transitional stage of decomposition. It is found in grassland soils where litter of low thickness (2-3 cm) is present. It is medium humified humus having C/N ratio ranging between 15-25. In this type of humus mineral organic complexes are weakly bound.

c. Mull: This is a fully decomposed organic matter showing high biological activity. It is dark colored having C/N ratio 10 and neutral p^H. It creates a stable mineral organic complexes.

Soil Organisms: Soil is the site of residence of different types of microorganisms like bacteria, fungi and actinomycees as well as useful insects/rodents like earthworms and harmful insects/rodents like nematodes. Microorganisms disintegrate dead remains of plants and animals into humus. The bacteria like Rhizobium and Clostridium fixes atmospheric nitrogen and add it to the soil and help in increasing fertility of soil. The earthworms makes the soil porous and improves soil aeration, its excretory products are rich in content of plant growth promoters which are beneficial for the luxuriant growth of plants. Soils also contans harmful animals like nematodes which enter in to the phloem of root and block the phloem transport therefore their eradication from soil is essential to achieve luxuriant plant growth.

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PESTICIDES - THREAT TO AQUATIC ENVIRONMENT

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Abstract:

The important source of life is water both surface water and underground water. The distribution of water is uneven. Therefore, India having only 4% of globe fresh water. Whereas 80% of water is been used in agriculture purpose. Central ground water board is of the opinion that ground water blocks are been overexploited. Since agricultural sector, is important in our country, and about 55% of population depends on agriculture. With the green revolution in the 2^{nd} half of twentieth century farmer started to use of advance technologies to enhance yield by using synthetic fertilizers, pesticides and herbicides are common around the globe. These chemicals were developed in the laboratory and this is been exercise great control over plants so that they grow by enriching the immediate response. Such environmental cost such as pollution of water bodies and the coastal areas. As there organic pollutant run off into nearby water ways.

Farmers use chemicals to prevent crops from disease, thus chemical are runoff into water bodies. Agriculture water pollution is mostly caused by pesticides and fertilizers. Research finding indicates that the insignificant of pesticides pollute the water through the leaching nitrate from nitrogenous pesticide. The various type of insecticides and pesticides in agriculture cause water pollution. The study describe and evaluate the present status of the pesticides and their adverse effect in aquatic environment has been discussed.

Keyword: Pesticides, water pollution, Effluent, Biocide, DDT, Organophosphate.

Introduction:

The air we breathe, the water we drink, the food we eat and the soil we grow plants on, are all polluted by pesticides. Pesticides are organic chemicals which are used to control unwanted and dangerous species of plants and animals. These are the economic poisons employed to regulate the impact of the various pests upon our life and economy. Pesticides include fungicides, bactericides, insecticides, nematicides and also the herbicides. Since weeds are not pests like insects, fungi or bacteria so a broader term 'biocide' can be used to include herbicides.

Now the uses of biocides have been increased by several folds. They play and important role in homes, industries, agriculture, and in irradiating dangerous diseases in plants and seeds to

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increase the food production. At present it was found that more than 10,000 of different pesticides are widely used. The contaminated environment endangers man, animal and plant life leading them towards most dangerous future. With the advancement of human civilization, there was an increased in the demand of food stuffs which consequently lead to manipulation of land resources causing a stress in the natural environment. The need of increased production as a result of population explosion was emphasized since long. Consequently protection technology was developed to save the crops during their growth periods and the grains during storage. The production and protection technologies are, however, so interwoven and interdependent that it is impossible to visualize a shoot up in crop reduction individually. In recent years, losses due to crop pests particularly on high yielding cultivated fields have been very high. But these pesticides enter into water systems, acutely affecting the living biota and aquatic environment.

Sources of pesticides:

Pesticides may enter aquatic ecosystems either directly or indirectly through the following sources,

1. Rain water
2. Spray drift
3. Runoff from agricultural fields
4. Industrial effluents
5. Domestic sewage

1. Rain water:

Pesticides contaminated in vapor phase in air get adsorbed on to the dust particles which ultimate reach soil or water along with the rain water. Tarrant & tatton detected residues of BHC, DDT and Dieldrin in rain water.

2. Spray drift:

Hindin et.al estimated that 30% to 40% of pesticides used in aerial spray reach the target while the rest fled into air. Water contaminates heavily with pesticides during accidental spray. Wind may also carry the drift to considerable distance while the major fall of pesticides take place near the site of application polluting ware system.

3. Run-off from agricultural field:

Generally water soluble pesticides are transported in water system while the insoluble once get bound to the particulates and carried by water streams. Carro & Taylor have reported that 0.07% of dieldrin applied to the soil persists in run-off water. Largest quantities of DDT in water were about 70 mg/l and 440 mg/l in mud.

4. **Industrial effluents:**

   A huge amount of pesticides are escaped by pesticides producing industries. In USA, a wood factory released 12 – 70 mg/l of dieldrin in water (Wilroi).

5. **Domestic sewage:**

   In the area i.e. Jammu and Kashmir the study found to be in the ponds of Reasi and in Nehru stream where the DDT present in the water bodies shows fish mortality, reported by ICAR 1970). DDT concentration in Yamuna water has risen from 0.25 ppb to 0.55 ppb after the Najafgrah Nallah drains sewage into these river in New Delhi. Besides these sources other factors like the amount of suspended particulates, accidental spillage, evaporation from soils and plants, forest cover, and residues in horticultural products influence the extent of pollution in water bodies.

Classification of pesticides:

Pesticides may be classified into following main categories-

1. Herbicides
2. Fungicides
3. Insecticides
4. Rodenticides
5. Nematicides

   1. **Herbicides:**

      These pesticides are used to kill weeds or undesirable vegetation's.

   2. **Fungicides:**

      Fungicides are toxic to fungi or mould and are used to control plant diseases.

   3. **Insecticides:**

      These are meant to kill insects in fields of agricultural.

   4. **Rodenticides:**

      These are used against rats and mice. Rodenticides Warfarin acts as anticoagulants and depresses prothrombin level which is a blood protein require for blood clotting. Sodium fluoroacetate, an extremely hazardous rodent killer, causes hyper stimulation of central nervous system and affects heart action. Excess of rodenticides eventually results in death from internal hemorrhage.

   5. **Nematicides:**

      Nematicides inhabit nematodes. Their traces are present in different aspects, drinking water, vegetables and fruits etc.

Effect of pesticides:

Pesticides acutely affect man, animal, plants and soil as well as the aquatic biota. Toxicity towards the aquatic flora and fauna is an important criterion for a pesticide to be considered as a hazardous pollutant. Pesticides harms in a different types of ways.

Effects on man:

1. Recently Ramchandran and Agrawal et.al have recorded higher concentration of DDT in body parts and blood of human beings causing anxiety, tension, cancer, mutation, stress reaction, congenital in uteri malformation and impotency.
2. Central nervous system is the target of DDT poisoning in man which ultimately leads to death.
3. Insecticides like BHC, Aldrin, Dieldrin, Chlorodane, and are extremely toxic to living beings. These are consider to affect the vital organs, heart, brain, kidneys, and liver producing chronic disturbance.
4. Chronic accumulation of pesticides plays a major role in liver and kidney malfunctioning, secretion of excess of amino acid in human blood and urine, blood abnormalities as well as deformations of brain tissues.
5. In Past, (Dec 3, 1984) Bhopal industrial disaster was the worst pesticidal MIC accident in history, taking a 3200 lives and affected nearly fifty thousand person. This leakage caused an increased risk of sleeping, digestive problems, vision problem, kidney and liver infection as well as the brain damaged.

Effects on animal:

1. Insecticide such as aldrin, dieldrin, chlordane, endosulfan and gammaxane are reported to affect the wildlife by changing their metabolic activities and body chemistry.
2. Recent reports have indicated that several farm animals died by drinking water stagnating in spread field and contaminated water.
3. Animals which have become weak as a result of exposure to pesticide may easily be destroyed by predators.
4. In higher animals, pesticide poisoning results in concentration of these chemicals in their passage through food chain.

Effect on birds:

Pesticide such as aldrin, dieldrin and several other organochlorines are reported to affect severally the metabolism in birds. Species of hunting birds, especially those having high levels of DDT and are threatened with extinction. Therefore DDT has been implicated as the main villain.

Need to prevent pesticides contamination:

Recent reports have indicated that our environment is polluted by pesticides and in fact the level of biocidal contamination has increased tremendously in various part of the world. Now the indiscriminate use of biocides could make them as an integral part of our biological, ecological, and chemical cycle of the earth. Enormous used of pesticides have created several new problems. Through DDT, BHC, and other biocides contributed much to mankind, the ecological damage is equally very high the environmental deterioration due to these insecticides and pesticides is threatening.

So additional treatments and disposal methods are extremely necessary to eradicate pesticidal hazards and to protect the terrestrial and aquatic environment.

Today there is an urgent need to control and prevent pesticidal pollution of water bodies where the environmental burden is increasing rapidly. The establishment of a Regular Monitoring is necessary in spite of technical difficulties. Bioassay of animals offers reasonable approach to this problem.

Therefor early remedial solution in terms of effective ecological management of the aquatic ecosystem is extremely necessary to restore normal condition of water.

Future strategy for pesticides use:

Pesticides hit the aquatic ecosystem and terrestrial organism ranging from acute toxicity to invisible serious chronic effects. So the question is how to best regulate pesticides used so as to minimize its nuisance hazards. Following steps may be useful-

1. Broad spectrum chlorinated pesticides (DDT etc.), must not be used.
2. Broad spectrum chlorinated pesticides (DDT etc.), must not be used.
3. Only selective pesticides should be used in trace quantities.
4. Repeated application of insecticides should be avoided.
5. Farmers, filed workers and public must be educated regarding the use of pesticides.
6. Cattle, cow and other grazing animals should be allowed to graze on the treated crops.
7. Monitoring and research should be encouraged to solve the pesticides problems.

One should strictly follow the suggestions so that the benefits of pesticides are not denied on account of their negligent used.

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A WAY TO SUSTAINABLE MINERAL DEVELOPMENT: COALBED METHANE

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Introduction:

Today, natural resource development is all about sustainable development. The major concern of the industry is now to use mineral sources in such a way that our future generation does not get deficient of the same. More than any other economic activity, mining has a tendency to have a detrimental impact on both society and the environment. The emphasis on sustainable development has increased recently due to the increased awareness of environmental issues, especially with regard to activities that harm the environment. Seeing to the negatively impact communities and the environment many such steps are taken for a sustainable ways in this sector. One such activity is mining.

A contrast is also presented by mining. It is one of man's earliest activities, and over time, the volume and variety of uses for minerals have grown to meet a variety of economical demands. As a result, for sustainable economic growth that would reduce poverty and improve quality of life, modern civilization, especially in growing economies like India, is critically dependent on the mining sector. Since contemporary civilization and culture are so reliant on minerals and mineral production, a complete prohibition on mineral extraction is not feasible. Closure of this sector in the coming future too is not possible as in the coming years the energy demand is to increase exponentially and this chapter we would be discussing about a sustainable development and mineral production in the case of COAL which is considered to be the most devastating form of mineral extraction where coal itself is a carbonized material whose extraction involves a tonne of activities that is harmful for the environment.

Self-awareness and good governance are the first steps in any process leading to sustainability. In contrast, the method we will discuss in this chapter is the conversion of a liability into an asset. As previously said, it is impossible to harvest coal without harming the environment, but if a substitute source of green energy could be extracted alongside coal, the situation might be balanced.

This chapter will cover a type of energy that is plentiful in coal seams and is already being used extensively in several countries, including China. It will also cover the current situation with regard to this type of energy in India.

Compared to coal, methane has a higher gross heating value per kilogramme at 13284 kcal/kg. One of the most unintentional causes of underground mining accidents is methane explosion.

The presence of methane in coal seams has long been recognised, first as a hazard and but more lately as an economically harvestable commodity.

As a result of this contrast alone, the necessity of emptying off the coal bed methane before it causes catastrophic damage is highlighted, as is the next comment.

In a world when carbon is scarce, the capture and use of Coalbed Methane will increase a country's energy security while also ensuring future mining is safe and advancing our efforts toward a low-carbon future.

The pollution issue has been out of control since the advent of industrialization, and the coal sector alone has made a significant contribution to it.

India now is on its way for clean energy sources and Coalbed Methane is a new area of exploration and should be worked. It would not only provide a clean source of energy but also would develop a nature of less accidental environment in the mines.

Coalbed Methane is a method to save face because methane is the main source of grey hydrogen, which India is moving toward using as a fuel. Numerous studies demonstrate the value and use of Coalbed Methane, with China serving as the finest case study due to its innovative utilisation of this fuel source to compete with the rest of the globe.

Coal: a potential source of clean energy

Coal is no doubt a dependable energy resource which have been helping us to develop and contributes to our energy and fuel demands since independence. The dependency on coal in our country is increasing day by day yet coal is considered to be a dirty fuel the reason being the unfriendly nature of coal extraction process to environment. The environment unfriendly emission right from production, transportation to utilization.

Coalbed Methane and its subset like coal mine methane or abandoned mines methane or ventilation air methane, are coal based clean energy source with a much larger potential than coal itself having its technological challenges.

Earlier methane was considered to be a hazard and was drained out in order to make the working of the mines safe as the accident due to methane gas explosion in the underground working has been a nightmare for miners. Coalbed Methane being almost of the similar composition of natural gas has proven itself to be an important source of clean energy.

Coalbed Methane is our way to less emission producing and more energy efficient technologies.

Formation of Coalbed Methane

Formation of methane and other associated gases have their origin linked to the coalification process. The basin burial history and variability of the regional geothermal heat flow control coalification and quantity of thermogenetic methane generation. On the other hand location, geometry of fold and faults effects the biogenic methane generation.

Basically, Just two genesis types of Coalbed Methane made up the majority of Coalbed Methane; i.e.

- Biogenic
- Thermogenic

Biogenic generation of methane

Biogenic gas is produced by the decomposition of organic vegetal matter accumulation in the peat swamp by methanogenic microbe's .Conditions favourable for the generation of significant amount of biogenic gases such as methane and carbon dioxide are

- Abundant vegetable matter
- Deficient oxygen environment
- Low temperature
- High Ph. Value
- Rapid Sedimentation

Further it may also take place in two stages Decarboxylation & fermentation. Decarboxylation is a process were, microbes having the ability to generate methane by reducing carbon dioxide. Fermentation whereas methyl group is converted to methane by the bacteria capable of decarboxylation of acetates.

Thermogenic generation of methane

With the increase in depth of burial or the vegetable matter methane along with carbon dioxide and water releases in large quantities due to the chemical changes and pressure and temperature change during the later stage of coalification process . The high volatile bituminous coal under this condition formed are termed to be of thermogenic formation.

Factors responsible for the formation of thermogenic generation of methane are

- Burial history
- Geothermal gradient
- Macerel composition
- Basin distribution

Studies have indicated that a certain threshold thermal maturity is required for the thermogenic generation.

Storage of Coalbed Methane within coal

Retention of gases by adsorption

Methane and other coal seam gases are kept in place by physically adhering to the coal's molecular structure and taking use of the weak attractive interactions (Van der Waals forces) that exist between molecules or atoms. By raising the temperature or lowering the pressure, adsorption of gases can be reversed. Adsorption of gases rises nonlinearly with pressure. In contrast to conventional oil and gas, where good source rocks frequently make poor reservoir rocks, coal is exceptional in that, depending on the circumstances, it may act as both an excellent source and a reservoir rock for hydrocarbons.

Open pore spaces (porosity), which are typically in the range of micrometres to millimetres in dimension and constitute 5-20 percent of the total rock volume, in conventional reservoir rocks provide hydrocarbon storage capacity. Of contrast, the porosity in coals is typically less than 5% and may even be as low as 1%, with the majority of the porosity being occupied by water in-situ. Present-day coal beds retain some of the coal bed gas produced during coalification.

- Adsorbed or Absorbed gas in a form of monomolecular layer within micro pores of coal;
- As free gas in cleats and fractures;
- Dissolved in ground water system.

Methane in coal are either

- Absorbed on the surface of coal
- Stored as free gas in the cleats and open pores

Stored as free gas in the cleats and open pores

The single most significant physical characteristic controlling gas flow in a Coal Bed Methane reservoir is naturally occurring coal fractures, often known as cleats. Cleat formation's "how, where, and why" are still up for debate.

However, endogenetic or exogenetic processes are the two primary mechanisms that are frequently mentioned for cleat development. The former occurs as a result of the coal's compaction and contraction due to desiccation and the coalification process, whereas the latter occurs as a result of the stress and strain that tectonic activity places on a seam as it is buried. In coal, cleats are typically two pairs of cracks that are perpendicular to one another (i.e. having an orthogonal geometry). According to the figure, the "facial cleat" is the predominant fracture system, whereas the "butt cleat" is less laterally continuous and almost always comes to an end when it crosses a face cleat. Cleats are perpendicular (or nearly so) to bedding and face cleats will typically strike perpendicular to the axes of folds and be parallel to normal fault systems.

Composition of Coalbed Methane

Coalbed Methane is mainly composed of CH_4, secondarily heavy hydrocarbon (C_2+), N_2, CO_2 and other minor composition including Ar, H_2, He, H_2S, SO_2, and $COCH_4$ content ranged from 66.5% to 99.98% and generally between 85% and 93%. The CO_2 content ranged from 0 to 35.6% and generally below 2%. The N2 content varies greatly but generally below 10%, and heavy hydrocarbon content varies with coal ranks.

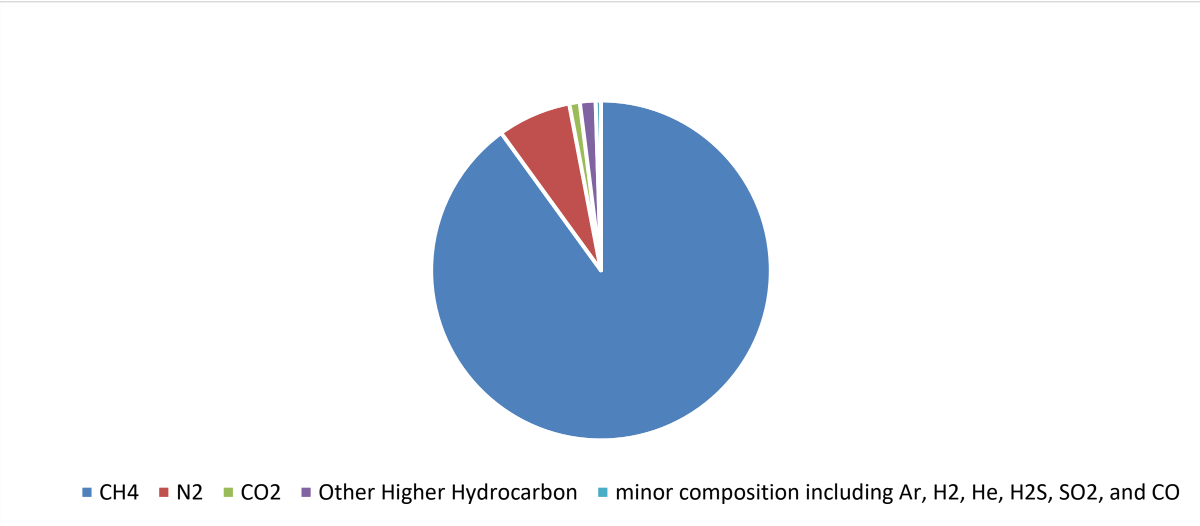

Figure 1: Graphical Representation of the composition of CBM

India scenario and development in Coalbed Methane

According to ministry of petroleum and natural gases the projected Coal Bed Methane resources are scattered throughout 11 States and amount to 2,600 Billion Cubic Metres (BCM) or 91.8 Trillion Cubic Feet (TCF). Currently only Moonidih AND Sudamdih mines of BCCL in Jharia Coalfield is operational generating electricity from Coal Bed Methane and Parbatpur under BCCL, Gomia and Barkagaon within CCL command area is under the exploration/pipeline.

Still the concerns and as listed by CMPDI are [8]

- Lack of latest technology
- Lack of expertise and experience
- Pervasive perception that commercial viability of exploitation and utilization of Methane is doubtful.

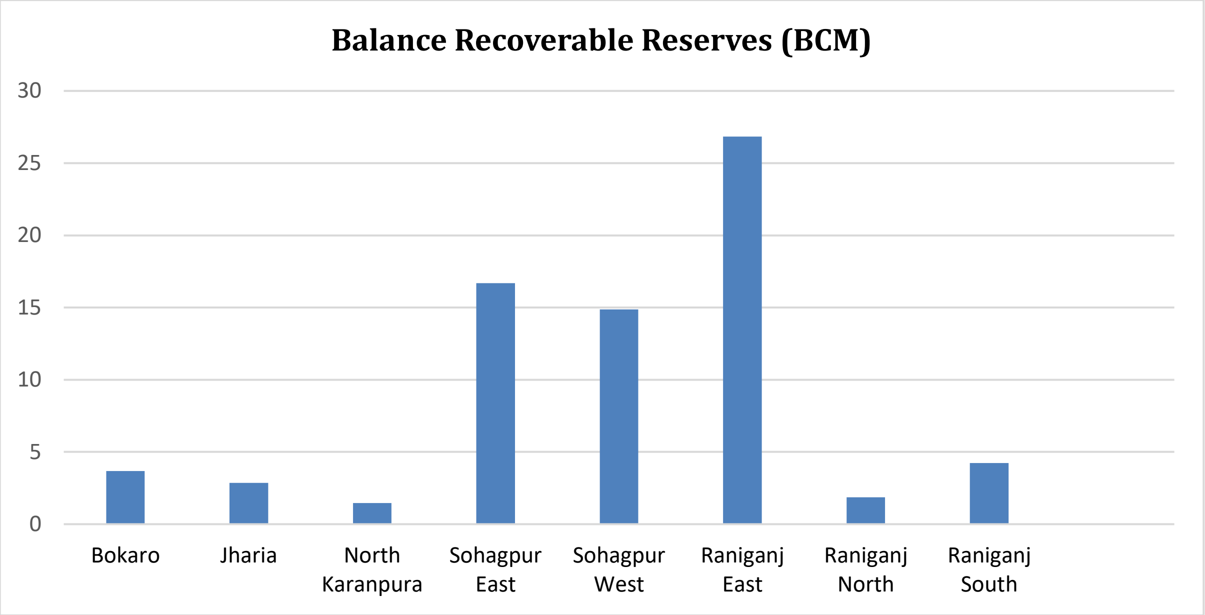

Figure 2: Balance Recoverable Reserves (BCM)

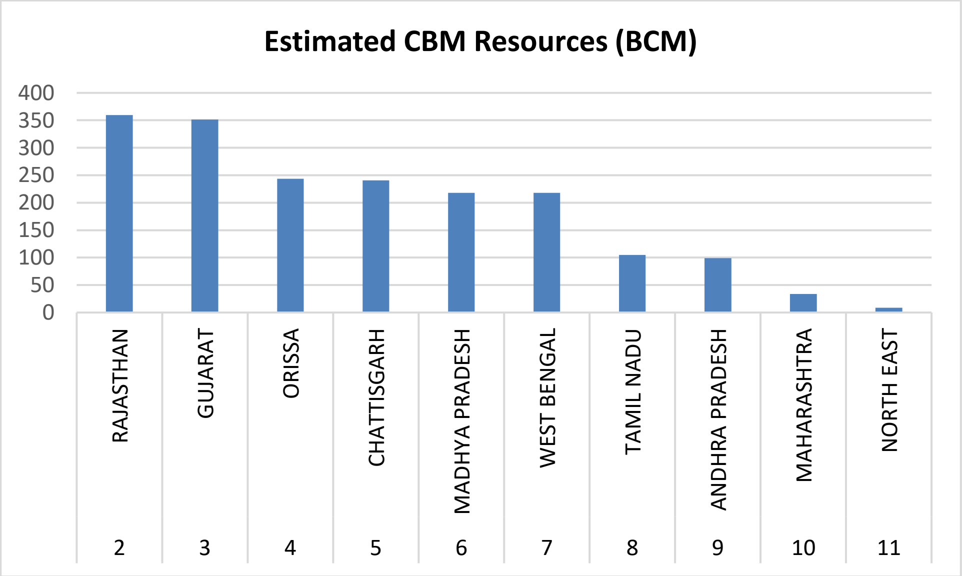

Figure 3: Estimated CBM Resources (BCM)

Ministry of petroleum and natural gases has taken initiatives 30 Coal Bed Methane blocks have so far been allocated by the government to national, private, and joint venture companies after four rounds of bidding. Additionally, two Coal Bed Methane blocks were awarded based on nominations, and one block was awarded via the FIPB process. Andhra Pradesh, Assam, Chhattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, and West Bengal are the states that contain these Coal Bed Methane blocks.

Conclusion:

The environment concerns has given us an opportunity to utilize hitherto entrapped clean source of energy in the form of Coal Bed Methane. There is vast potential in development of coal based additional energy resource viz Coal Bed Methane and its subsets.

The uses of Coal Bed Methane are Clean Burning Fuel for Domestic and Industrial, Motor Fuel Electricity Generation, Mine Boilers, Community Needs and with such vast utility and international pressure on India by the European nation for the sanction tax on carbon emission.

Indian Coal Bed Methane is way behind the United States and china where the countries have started at a full-fledged production of Coal Bed Methane, India is on the primary stage of exploration and bidding.

Coal Bed Methane is not only a green source of energy but also the way to achieve a safer working environment for miners leading a helping hand to achieve the goal of zero accident potential mines at a rapid rate.

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APPLICATION OF PLANT TISSUE CULTURE: REVIEW

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Abstract:

Since the dawn of the era of biotechnology, scientists have been trying to develop plants with higher yield, better resistance to pest and diseases, tolerance to various stress condition and requiring low fertilizers. The in *vitro* culture of plant cells or tissues in artificial medium is said to be plant tissue culture. It has many applications in crop improvement, preservation, and breeding and in industries.

Keywords: Micro propagation, callus culture, Synthetic seeds production, Germplasm storage

Introduction:

Plant tissue culture is a collection of techniques used to maintain or grow plant cells, tissues or organs under sterile conditions on a nutrient culture medium of known composition. Research in plant tissue culture over the past several decades has led to the development of techniques now used commercially across the globe to rapidly multiply a wide range of crops and improve their production systems (Zulkarnain *et al.*, 2015). Touchell *et al.* (2008) studied Novel applications of plant tissue culture.

Clonal propagation (micro propagation)

Regeneration of plantlets develop by clonal propagation has been achieved in many trees of high economic value. Many of these study in this connection are aimed at large scale micro propagation of important trees supplying fuel, pulp, timber, oils and fruits, therefore, clonal forestry and horticulture are gaining great importance. Recently rapid and bulk multiplication has been attended in the plants like *Eucalyptus, Bamboos, Sandalwood, Pinus, Coffee, oil palm, Citrus, Mango, Grape* and ornamental plants like *Orchids, Gerbera Chrysanthemum*, etc. Many plants which are difficult to grow by cutting and grafting are known propagated by clonal propagation technique. Molsaghi *et al.* (2014) screened efficient protocol for rapid Aloe vera micropropagation. Shah *et al.* (2013) observed Micropropagation technique in *Litsea glutinosa*.

Crop improvement

Fifty varieties of rice and twenty varieties of wheat have been improved through tissue culture. Another culture produces haploid plants Diploid/polyploidy is produced by treating the colchicines in laboratory. High yielding plants may be obtained by gene manipulation followed by tissue culture. Somaclonal variation may be utilized in crop improvement as it reduces the time required for releasing new variety by at least two years as compared to mutation breeding and three years in comparison to back cross method of gene transfer. Crop resistance to disease may be produced through gene manipulation followed by tissue culture.

Horticulture

Many horticulture plants like orchids and *Chrysanthemum* are produced through tissue culture. Orchids, an important horticultural plant, require *Rhizoctonia* a fungus association, for germination. This association is of symbiotic nature. The Orchids seeds are very minute and lack stored food. Embryo is virtually naked. Orchids can be grown commercially through tissue culture without fungal association.

Synthetic seed production

Artificial seeds can be handled as seeds being used in agriculture and horticulture. Embryoids produced by callus tissues are preserved in thin layer of calcium alginate. Synthetic seeds have calcium alginate covering. Calcium alginate prevents embryoids from desiccation. Preserved embryoids are called synthetic seeds. The synthetic seeds breed true. The artificial productions of seeds of *Santalum* are of considerable importance. They are used to propagate male and female sterile plants for breeding programs.

Forestry

One of the most important aspects of tissue culture technology is rapid regeneration of forest plants. Hundreds of timbers yielding plants of *Tectonagrandis*, *Eucalyptus spp*. have been cultured by scientists of National Chemical Laboratory, Pune, from a single in a year through micro propagation.

Propagation of rate plants

"Mukapuno" a rare variety of coconut, which has only solid endosperm unlike other coconuts, which have solid and liquid endosperm both can be propagated through tissue culture. Solid endosperm develops at the cost of liquid endosperm.

Production of secondary metabolites

Plant tissue culture is an important tool in the production of secondary metabolites. In recent years it has been shown that the broad spectrum of compounds that are produced in culture is even outside the ability of whole plants. It has wide range of application in pharmaceutical, chemical and food industry. Secondary metabolites (eg. Alkaloids, flavonoids, phenolics, steroids) are now cultured *in vitro* by plant tissue culture for meeting its demand in short period. "Ephednine" is produced at Jodhpur University, "Atropine", "Barberine at Rajasthan University, Jodhpur via tissue culture

Table 1: Common secondary metabolites from plant cell culture

Sr. No.	Compound	Plant species
1	Shikonin	*Lithospermum erythrorhizon*
2	Anthraquinones	*Morinda citrifolia*
3	Ajmalicine	*Catharanthus roseus*
4	Berberine	*Thalictrum minor*
5	Nicotine	*Nicotiana tabacum*

Shortening of breeding cycle

Embryo culture also reduces breeding cycle length. Breeding cycle length is generally due to long dormancy period of seeds. One complete year is required by *Rosa spp*. to come into flowering but this period has been reduced to half using in vitro embryo culture technique.

Production of disease-free plants

Under normal conditions plants are infected by a wide range of pathogens such as bacteria, fungi, viruses, viroids and insects. Majority of perennial and vegetative propagated plants are infected, with one or more pathogens, which reduces the yield. Surface sterilization of tissue removes fungal and bacterial pathogens, but viruses are not removed by surface sterilization. Virus infected tissue culture will produce diseased plants. Hence, it is desirable to take explants from virus free tissues. In plants, such tissues are only apical meristems, where viruses cannot enter and survive even in infected plants.

Anther and pollen culture formation of androgenic haploids

It is most useful application of tissue culture technique. For this method, either anther cells or the pollen grain is taken as explants. If the pollen grains are taken as explants then from these pollens by tissue culture, haploid embryo (embryoid) are formed. Purwoko and Khumaida (2007) studied Rice anther culture to obtain doubled-haploids with multiple tolerances. Theseembryoid can be used to produce haploid plants when required. These are called androgenic haploids. This was introduced by Tulecks in 1951. Maheshwari and Guha in 1964 produced androgenic haploid of *Datura innoxia*. This technique is used for rice, wheat, maize, rubber, etc.

Somatic hybridization

From the cell culture by using the cell wall digesting enzymes, protoplast culture can be produced. Inter specific and inter generic cross can be made possible by using this protoplast culture.The protoplast from two different plants can be made to fuse by using fusogenic agents as polyethylene glycol (PEG) from the resultant combined protoplast by tissue culture; a new plant variety can be produced.

a. *Potato* + *Tomato* = Pomato
b. *Raphanus* + *Brassic*a = Raphanobrassica

Embryo rescue

In some plants, normal fertilization takes place, but the ovule fails to become a seed. In such cases, the immature embryo is taken from the immature fruits and culture in a tissue culture medium. Consequently, plants develop from the embryo. As this method overcome embryo immaturity, it is often known as embryo Rescue –

Germplasm storage

The gene pool for the breeding programmes comprises of genetic diversity of wild and primitive varieties of crop plants. The genetics resources of our planet are fast depleting as species extinction is taking place at an unprecedented rate due to natural and anthropogenic stress. The International Bureau of plant Genetics Resources (IBPGR), established to develop a global network of genetic resource, is involved in collection, conservation, evaluation and exchange of germplasm all over the world. Plant tissue culture techniques have been able to achieve this goal. Success has been achieved in the field collection of able germplasm of mango, cassava and some other plants using tissue culture techniques. The plant materials (*Rubber, Mango, Cocoa, Litchi, neem, Jackfruit*) are stored in a minimal medium with low intensity (10 ^{0}C -20 0C). Such a medium reduces the growth rate of plant tissue culture.

Transgenic plants

By genetic engineering now it is possible to alter the gene make –up of a plant by introducing a novel gene. These plant whose original gene make –up was altered is called transgenic plant. Many transgenic plants with herbicide resistance, insect resistance, modified products, and vaccination property are developed in this way.

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CHEMISTRY IN DAY TO DAY LIFE

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Introduction:

Simply Chemistry can be defined as branch of science which is the study of properties, composition, and structure of elements and compounds. From above definition we might think that Chemistry is related with chemicals in the laboratory only but accidentally we are applying it in our daily workings. We all are surrounded by chemistry, but most of us are not aware of that fact. In our daily life we can observe that Chemistry is very-very important as it plays a big role in our daily life routine. In our daily life large numbers of activities we came across are related to Chemistry. For our body growth we eat a food which have chemistry, as the food contain organic compounds like carbohydrates, sugar, starch, lipids and nutrients like water, minerals and vitamins are nothing but chemicals. Plant makes their food with the help of light, carbon dioxide and water in photosynthesis which is chemical reaction. The food we eat is digested and converted into energy, the digestion of food occurs by enzymes which breakdown the food is chemical reaction. Cosmetic products like face creams, anti-aging creams, lipsticks and cleansing products like detergents, soaps, shampoos are also chemical products synthesized in laboratory. In agricultural industry which is main Industry different products like pesticides, fungicides, fertilizers, plant growth hormones are also chemical products. Also in pharmaceutical industries different medicines which are manufactured are also chemical compounds. Even different emotions we feel like happiness, respect, love, frustration, jealousy etc. are due to some chemicals in our body which is also the part of chemistry.Hence the role of Chemistry in our day to day life is very important. Thus in our life from born to death we came across Chemistry.

Applications of Chemistry in our day to day life:

In our day to day life we came across number of applications of Chemistry like

a) Toothpaste: When we wake up early in the morning our day started with cleaning of our teeth. For cleaning teeth we use toothpastes like colgate, Sensodyne, oral-B, dabur, meswak, pepsodent, babool, close-up etc. which is a mixture of chemical compounds like baking soda (sodium bicarbonate), calcium carbonate, along with fluorides, Saccharin, Aspartame, Carrageenan and some antibacterial agents like Triclosan(5-Chloro-2(2, 4-dichlorophenoxy) phenol) which is a halogenated phenol.

b) Cleansing products like detergents and soap: In our daily routine we use soaps to clean our body, to kill germs present on our hand. Soaps are made up of fatty acids like stearic acid, palmitic acid, oleic acid etc. while detergents are made up of Sodium Laureth Sulfate, Sodium Lauryl Sulfate, Phosphates etc. Soaps and detergents are surfactants which are used as cleaning agents to remove of dust and oil.

c) As a preservatives to protect food from decay. To increase the durability of food and to prevent it from bacterial spoilage number of chemicals are useful and are act as preservatives. Salt, oil, sugar are some common household preservatives. Some chemicals like sodium benzoate, benzoic acid, acetic acid, sodium sorbate, potassium sorbate etc. are also used effectively against wide range of spoilage organisms to preserve the foods.

d) Cosmetics: We use cosmetics to improve the look of our body. We are using different products like Lipsticks, oils, beeswax, perfumes, nail polish mascaras etc. which contains different chemicals like polymers, solvents, grease, petroleum oils, colorants, pigments, etc.

e) Drugs and medicine: Chemistry plays very important role in making different medicines. All the medicines used for the treatment of disease of to improve the health are different chemical compounds. Similarly in agriculture different pesticides, fertilizers, plant growth regulators which are used to improve the crop yield are chemical compounds. Even in our day to day life we use vehicles for transport needs fuels like petrol, diesel etc. which are also chemicals like hydrocarbons. So chemistry paved the way for modernization in daily life. In this topic we are going to discuss in detail about the chemical compounds available naturally and their medicinal importance in our day to day life. The main aim of this chapter is to provide a brief summary of natural products derived from plants and their silent features.

Natural products:

The term "Natural Product" is defined as a chemical compound or substance which is produced by living organisms (such as plants, insects, animals, marine organisms, etc). It refers to secondary metabolites which differ in their biological functions as compared to the primary metabolites (e.g. proteins and carbohydrates) and the semantides (e.g. nucleic acids). Most of the natural products belongs to plant origin and show well-defined biological functions though they are not essential to life.

The secondary metabolites are broadly classified as terpenes, alkaloids, flavonoids and related compounds, such as anthocyanins, isoflavones, neoflavonides and condensed tannins and polyketides. The biosynthesis of these compounds involve primary building blocks like isopentenyl pyrophosphate, different amino acids, shikimic acid (also serves as precursor for aromatic amino acid i.e. phenyl alanine) and a combination of acetyl coenzyme-A and malonyl coenzyme-A. Each class of secondary metabolites has a great number of compounds representing a wide variety of skeletal structures, peripheral features and molecular size. From prehistoric times different plants have been used as a source of medicines. Some of very commonly used medicinal plants are aloe, cannabis, castor bean, garlic, juniper, and mandrake are listed by the ancient Egyptian Ebers Papyrus. Large number of uses are mentioned in Indian Ayurveda. Now a days ayurvedic medicines are popularly used due to their different advantages over synthesized drugs.

Examples of Natural products from plants and their applications:

1] Alkaloids:

Alkaloids are bitter-tasting chemicals, very widespread in nature, and often toxic, found in many medicinal plants. Examples: morphine, codeine, coniine, quinine, scopolamine, atropine, caffeine, etc.

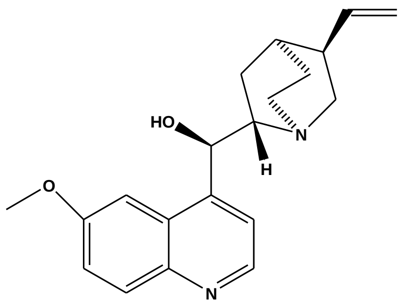
1. Quninine:

Genus: *Cinchona*

Family: Rubiaceae

Biological Source: cinchona bark

Structure:



Properties and uses:

Antipyretic, anti-malarial, non-narcotic analgesic, anti-inflammatory and muscle relaxant. Quinine is used to treat malaria, babesiosis, lupus, arthritis, psychological disorders, etc.

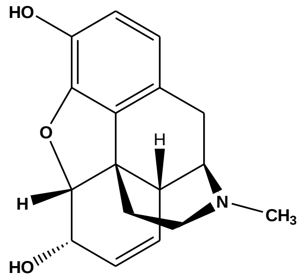
2. Morphine

Genus: Papaverv

Family: Papaveraceae

Biological Source: Extracted from unripe but fully grown capsules of Papaver somniferum

Structure:



Properties and uses:

Antioxidant, narcotic analgesic, used for opiate substitution therapy (OST) for persons with opioid addiction, remedy in convusions, used as antagonist for poisonous effects of other alkaloids, reduces acute and chronic pain, symptoms of shortness of breath.

2] Terpenes

Terpenes are a class of natural products consisting of compounds with the formula $(C_5H_8)_n$.

Examples: geraniol, terpineol, limonene, myrcene, linalool, hinokitiol, pinene, etc.

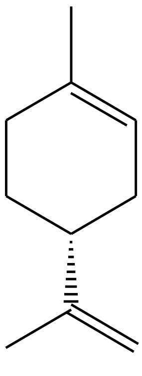
1. Limonene:

Genus: citrus

Family**:** Rutaceae

Biological source: in the rind of citrus fruits, such as lemons, limes, and oranges

Structure:



Properties and uses:

Anti-inflammatory, antioxidant, anticancer, and heart-disease-fighting properties, used for obesity, cancer and bronchitis, as additive in foods, cosmetics, cleaning products, and natural insect repellants, reduces appetite, stress and anxiety, supports healthy digestion, act as biofuel, help medicinal ointments and creams to penetrate the skin.

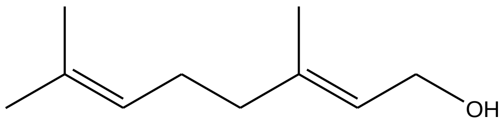
2. Geraniol:

Genus: Cymbopogon

Family: Lamiaceae

Biological Source: found within many essential oils of fruits, vegetables, and herbs including rose oil, citronella, lemongrass, lavender, and other aromatic plants

Structure:



Properties and uses:

Antibacterial, antioxidant, anti-inflammatory, insecticidal and repellent properties and used as a natural pest control agent, used in perfumes, represent a new class of chemoprevention agents for cancer.

3] Flavonoids:

Flavonoids belong to a class of polyphenolic secondary metabolites found in plants, and thus commonly consumed in the diets of humans.

Examples: kaempferol, quercetin, myricetin, fisetin, etc

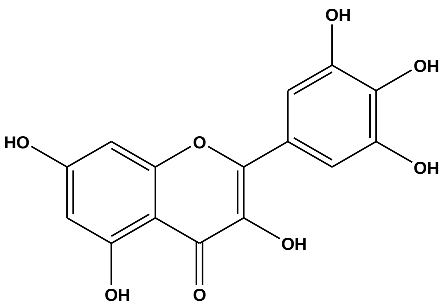
1. Myricetin:

Genus: Myrica

Family: Myricaceae

Biological Source: vegetables, fruits, nuts, berries and tea medicinal plants

Structure:



Properties and uses:

Anti-platelet aggregation activity, Anti-inflammatory, Neuroprotectant, Antiatherosclerotic, Antidiabetic, Antithrombotic, Antiviral, Anticarcinogen, Antioxidant, neuroprotective, possess nutraceuticals value, the key ingredients of various foods and beverages.

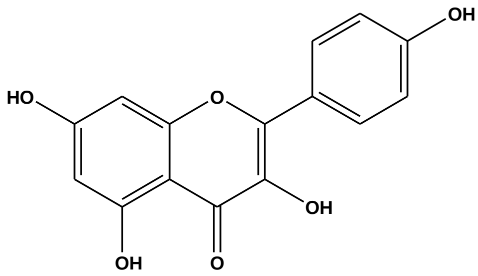
2. Kaempferol:

Genus: Phyllanthus

Family: Phyllanthaceae

Biological Source: The leaves of wild leeks or ramps, found in a variety of plants and plant-derived foods including kale, beans, tea, spinach, and broccoli, herbs such as dill, chives, and tarragon.

Structure:



Properties and uses:

Antioxidant, antiinflammatory, antimicrobial, anticancer, cardioprotective, neuroprotective, antidiabetic, antiosteoporotic, estrogenic/antiestrogenic, anxiolytic, analgesic and antiallergic activities, modulates apoptosis, angiogenesis, inflammation, and metastasis

4] Anthocynines:

Anthocyanins are colored water-soluble pigments belonging to the phenolic group

Examples: pelargonidin, cyanidin, delphinidin, peonidin, petunidin and malvidin, etc.

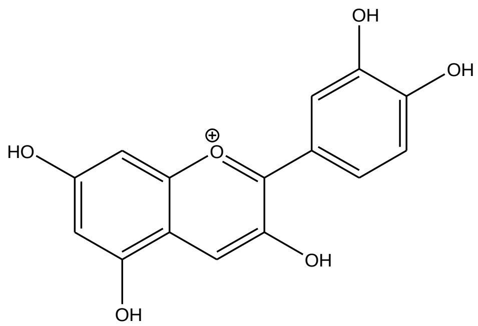
1. Cyanidin:

Genus**:** Rhaponticum

Family: Asteraceae

Biological Source: Red-colored berries like grapes, blackberry, cherry, cranberry, raspberry; fruits like apples, peaches, plums and vegetables like red cabbage and red onions

Structure:



Properties and uses:

Strong antioxidant and radical-scavenging activity, reduce the chance of cancer, as a metabolite, a neuroprotective agent, its glucoside Cyanidin-3-Glucoside (C3G) has ability to decrease blood glucose levels.

5] Tannins

Tannins belong to a class of astringent, polyphenolic biomolecules that bind to and precipitate proteins and various other organic compounds including amino acids and alkaloids.

Examples: Gallic acid, Phloroglucinol, Flavan-3-ol, etc.

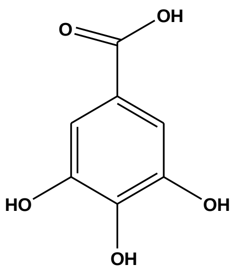
1. Galic acid

Genus: Acacia

Family: Leguminosae

Biological Source: found in the leaves of bearberry, in pomegranate root bark, gallnuts, witch hazel, sumac, tea leaves, oak bark, and many other plants, both in its free state and as part of the tannin molecule.

Structure:



Properties and uses:

Antioxidant, anti-inflammatory, antineoplastic, antimicrobial, and anti-obesity properties, used to produce dyes, means of detecting an adulteration of verdigris, a cyclooxygenase-2 inhibitor, as an astringent, as a plant metabolite.

Advantages of natural products:

- There is high probability to find physiologically active compounds in nature since there is often an evolutionary advantage in an organism producing a physiologically active compound (e.g. as a defense chemical)
- Many natural compounds exhibit totally novel structures and have not been synthesized before.

- Many natural compounds (e.g. toxins) are quite complex in nature with a highly rigid structure and have the active conformation or relatively few numbers of conformations, because of which they show high potency and selectivity for the target.

Disadvantages of natural products:

- The natural product may only be present in small quantities in the natural source and thereby restricting its availability.
- Isolation and purification of a natural product from its natural source is often slow, tedious and costly.
- It is difficult to synthesize many natural products on commercial basis due to their complexity. So it is tough to produce analogues of the natural product

Conclusion:

Thus from above discussion it is realized that every minutes, everywhere we came across Chemistry. Without Chemistry our life is not possible. Effective and good use of Chemistry is need of today's world. Hence we all must learn it and enjoy it.

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THE EFFECTS OF FOOD COLOR ON HUMAN HEALTH

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Introduction:

Food Colors are the substance that increases color of the food or drink. And also It plays a major role in the taste and perception of the food along with flavor and texture. To influence the consumer to by products through visual perception. Colorants are used in the production of soft drinks, candies, bakery products, canned and vegetable products, dairy products, and meat and fish products.

Natural colours:

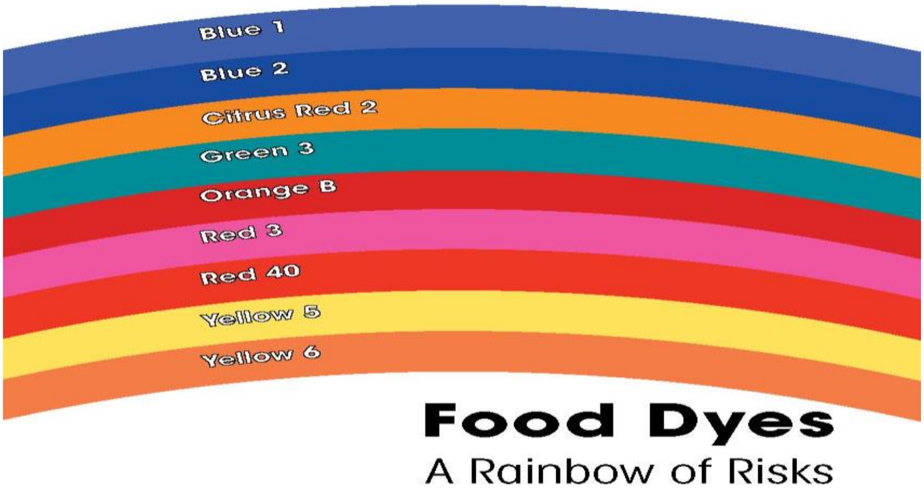
The Natural food colors come from variety of sources like seeds, fruits, vegetables, alage, and insects, grass, beetroot, and turmeric are the natural sources from which colours are extracted and it is safe to eat. Natural dyes have been used for centuries to color food. These food colorings are approved for use in all types of food. Although there are other natural colourings that are only approved for certain uses. Synthetic Iron Oxide only allowed in sausage casings, Ferrous Glutonate and Ferrous Lactate allowed in ripe olives. Anthocyanins (E163): found in beetroot, raspberries, and red cabbage. Gives red, blue, and violet, color.

- Chlorophyll (E140, E141): found in all leaves and stem. Gives green color.
- Carotenoids (E160, E161, E164): found in carrots, tomatoes. Gives yellow, orange, red, color.
- Betanin (E162): water soluble rex, orange, violet, yellow colors found in plants, beetroot. Used in bevrages, jam-jellies, icecream.
- Annatto (E160b): It is a reddish- orange dye made from seed of achiate. Used in custard powder, baked goods, seasoning.
- Carmel colouring (E150a-b): It's caramelized sugar. Used in Beer, brown bread, chocolate, cookies, spirits and liquor, fillings and toppings, dessert mixes, doughnuts, fruit preserves, ice cream, soft drinks (especially colas), sweets.
- Carmine (E120): It is a red dye made from red bodies of cochinel insect. Used in meat products, beverages, and yoghurt.

- Turmeric (E100): Provides bright lemon- yellow color. Used in ice cream, dairy products, confectionaries.
- Saffron (E164): Derived from the flower of saffron crocus, used in confectinaries, and liquors.
- Lycopene (E160d): It gives bright red color, found in tomatoes, redcarrots, watermelon, grapes fruits, and papaya.
- Paprika (E160c): It's obtained from fruits of capsicum annum (red chillies) used in cheese, E160d spice mixture, sauce and processed meat.

Artificial colours:

Artificial food dyes are from coal tar and petroleum. Many dyes have been banned because their effects on the animals (Rewa Kumari *et al.,* 2016) Aniline was the first petroleum product that is a toxic compound from which chemically Synthesised colors derived. Artificially



Synthesised colours are less costly to produce, attractive, highly, concentrate, widely available (Kobylewski *et al.,* 2010).

- Blue1 (Brilliant Blue): It is a greenish-blue dye, used in icecream, packaged soups, canned peas. These can cause hypersensitivity reactions and also cause the kidney tumors in mice.
- Blue2 (Indigo Carmine): Royal blue dye, Found in candy, cereals, snacks and icecream. It causes tumors particularly brain gliomas in male rats.
- Citrus Red 2: Formed by skin of orange. It is not used for processing because it causes tumors in urinary bladder and also other organs.
- Green 3: It can increase tumors in bladder and testes of male rats, but it's safe according to the Food and Drug Administration (FDA).

- Orange B: Used in sausage casing. FDA has approved to use this dye but when heated it emits the toxic fumes.
- Red 3 (Erythrosine): A cherry-red color. Used in candy, popsides and cake decorating gels. It was recognized by FDA in 1990. As it causes thyroid carcinogen in animals but still it's permitted in ingested drugs and food with 200,000 pounds of the dye used.
- Red 40 (Allura Red): A dark red dye, used in sports drinks, cereals, candy, it may seem immune system tumors in mice and causes the hypersensitivity reaction.
- Yellow 5 (Tartrazine): A lemon-yellow dye, found in chips, candy, soft drinks, cereals, popcorn. It is contaminated with cancer causing chemicals. And causes hypersensitivity reaction, triggers the hyperactivity and other behavioral effects in children.
- Yellow 6 (Sunset Yellow): An orange-yellow dye, used in sauces, baked goods, candy and preserved fruits. Causes the adrenal tumors in animals. It may contaminated with cancer causing chemicals, and causes hypersensitivity reaction.

Harmful effects on human health

Hyperactivity in Children

In 1973, a pediatric allergist claimed that hyperactivity and learning problems in children were caused by artificial food colorings in food. Red 40 triggers hyperactivity in children. Yellow 5 linked to hyperactivity, hypersensitivity, and other behaviral effects in children's. 2004 analysis of 15 studies concluded that artificial food dyes increase hyperactivity in children (Bell *et al.,* 2017).

Inflammation and Disrupt functioning of immune system

Artificial dyes can cause an inflammatory response in the body. Which increase the amount of WBC entering the bloodstream. Artificial colors cause description in immune system. Red40, Yellow 5,and Yellow 6 are contaminated with cancer causing chemicals (4-aminobiphenyl, 4-aminoazobenzene and benzidine). Red3 cause carcinogen in animals (Bell *et al.,* 2017).

Cancerous tumors

Artificial food colors do great impact on the human as well as animal's health. Citrus red 2 can cause bladder tumors in mice and rats. Red 3 cause thyroid tumors in rat. Blue 2 linked with brain and bladder tumors in rat. Red 40 may caues the reticuloendothelial tumors in mice. Yellow 6 cause adrenal and testicular in rats (Shea, 2020).

Allergies

Artificial food colors cause allergic reaction. Yellow 5 causes hives and asthma symptoms. Red 40, Yellow 5, Yellow 6, are most commonly consumed dyes that cause an allergic response in human (Bell *et al.,* 2017).

(Nitin kacharia August 2016) The eight artificial colors that are permitted by FSSAI to be used

- Red from: Ponceau4R, carmoisine, and Erythrosine.
- Yellow from: Tartrazine and sunset yellow FCF. (FCF- For Colouring Food)
- Blue from: Indigo carmine and brilliant blue FCF.
- Green from: Fast green FCF.

Banned artificial food coloring

- These food coloring is no longer safe for human consumption.
- Red number 2,4and 32
- Orange number 1 and 2
- Yellow number 1,2,3 and 4
- Violet number 1

Conclusion:

Color agent in food plays an important role. Color make food items more attractive to consumers and appealing to taste. Natural food colors are good for health but artificial food color is not good for health, this should be controlled. Artificial food dyes consumption in children are the biggest consumers (Rewa Kumari *et al.,* 2016).

Artificial food color causes health effect such as cancer, hyperactivity, hypersensitivity in children, allergies. Most allergic reaction are not life threatening. Both natural and artificial food colors have their own limitations and properties. It was used in different food products for different purpose. Artificial food colors are completely made up of chemical compounds that can be harmful to humans. This may cause a huge effect on our cells, which in turns effects our health. So choose healthy naturally coloured food in your body which may not effective to human body.

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ENVIRONMENTAL POLLUTION: CAUSES AND CONSEQUENCES

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The concept of environment is as old as the concept of the nature itself. It is a composite term referring to conditions in which organisms consisting of air, water, food, sunlight etc., thrive and become living sources of life for- all the living and non-living beings including plant and animal life. The term also includes atmospheric temperature, wind and its velocity.

Pollution:

The introduction by man into the environment of substances or energy liable to cause hazards to human health, harm to living resources and ecological systems, damage to structure or amenity or interference with legitimate uses of the environment".

The release (into any environmental medium) from any process of substances which are capable of causing harm to man or any other living organisms supported by the environment.

Pollution occurs when there is the potential for harm. Harm of man is not confined to physical injury but encompasses offence caused to any of his senses or harm to his property, therefore smells and noise which I may not cause injury can constitute pollution. Harm to living organisms can include harm to their health or interference with the ecological systems of which they form a part".

Types of pollution:

Environmental pollution may broadly be classified into: (1) Natural pollution; (2) Man-made pollution.

1. Natural Pollution: Environment is polluted often by natural phenomenon, such as earthquakes, floods, drought, cyclones, etc.

2. Man-made Pollution: Human activities.

The environmental pollution can also be classified further as, Air pollution, water pollution, land pollution, food pollution, noise pollution and radio-active pollution, etc.

Factors of environmental problems:

The environmental crisis is caused due to environment and ecological changes as a result of developmental process of the "economic and technological man" of the present century. In fact if the present century is marked by socio-economic, scientific and technological development on the one hand, it is plagued by serious problems of environmental problems on the other hand. The environmental crisis arising out of the environmental deterioration caused by several forms of pollution, depletion of natural resources because of rapid rate of their exploitation and increasing dependence on energy consuming and ecologically damaging technologies, the loss of habitats due to industrial, urban and agricultural expansion, reduction and loss of ecological populations due to excessive use of toxic pesticides and herbicides and loss of several species of plants and animal due to practice of monoculture removal of habitats through forest clearance has now become of global concern. The life of common man is being so rapidly adversely affected by environmental degradation caused by man himself that there has been a marked growth of interest within the last decade in the quality of the environment, the disruption of the earth's natural ecosystems and the depletion of resources.

The most striking reason of the environmental degradation and hence global environmental crisis is the fact of deteriorating relationship between man and environment because of rapid rate of exploitation of natural resources, technological development and industrial expansion. The rate of environmental change and resultant environmental degradation caused by human activities has been so fast and widespread.

The impact of man on environment through his economic activities are varied and highly complex as the transformation or modification of the natural condition and process leads to a series of changes in the biotic and abiotic components of the environment. The impacts of man on environment fall into two categories (i) direct or intentional impacts and (ii) indirect or unintentional impacts, Direct or intentional impact of human activities are preplanned and premeditated because man is aware of the consequences, both positive and negative of any programme which is launched to change or modify the natural environment for economic development of the region concerned. The effects of anthropogenic changes in the environment are noticeable within short period and these effects are reversible. On the other hand the indirect impacts of human activities on the environment are not premeditated and preplanned and these impacts arise from those human activities which are directed to accelerate the pace of economic growth, especially industrial development.

The indirect impacts are experienced after long time when they become cumulative. These indirect effects of human economic activities may change the overall natural environmental system and the chain-effects sometimes degrade the environment to such an extent that this becomes suicidal for human beings.

Main causes of environmental pollution:

The problem of environmental pollution, we face today, is a complex consequence of forces connected with various interrelating factors. There are clearly a number of divergent and conflicting views of what could be the basic factors underlying the environmental crisis. No single cause can be considered as the root cause of environmental impairment. However, the following causes could be pointed out as the generally underlying factors though each of these too could be operating simultaneously and their balance may vary from place to place and through time.

1. Population growth:

Modern thinkers consider that growth of population is the root cause for many human problems. This observation also applies to environmental degradation. Increase in the population will have a multiplier effect requiring proportionate increase in al requirements necessary for the existence of human beings. Population growth requires abnormal exploitation of natural resources to provide day-to-day essential requirements of life. It results in migration of people and growth of urban areas, thereby inviting new problems of health, ecology and human sustenance.

2. Nature of Modern Technology:

The nature of productive technology in recent years is closely related to the environmental crisis. Commoner maintains that sweeping transformations of productive technology since World War II productive technologies with intense impacts on environment have displaced less destructive ones. This factor has been largely responsible for the generation of synthetic and non-biodegradable substances such as plastics, chemical nitrogen fertilizers, synthetic detergents, synthetic fibres, big cars, petrochemical and other environmentally injurious industries and 'disposable culture. Thus, environmental crisis is the inevitable result of a counter ecological pattern of productive growth. Ecologically benign technologies did and do exist but they are not utilized, for they are considered inconsistent with the short-term interests of private profit maximization.

3. Deforestation:

Forests are invaluable property of a nation because they provide raw materials to modern industries, timber for building purposes, habitats for numerous types of animals and micro-organisms. Good fertile and nutrient-rich soils having high content of organic matter, offer protection to soils by binding the soils through the network of their roots and by protecting the soils from direct impact of falling raindrops. They encourage and increase infiltration of rainwater and thus allow maximum recharge of groundwater resources, minimize surface run-off and hence reduce the frequency, intensity and dimension of floods. They help in increasing the precipitation; they are natural sink of carbon dioxide because they use carbon dioxide to prepare their food during the process of photosynthesis. They provide firewood to millions of people all over the world and food and shelter to innumerable humans and animals. In fact, forests are 'life line' of a nation because prosperity and welfare of the society directly depends on sound and healthy forest cover of a nation concerned. Forests are main component of the biotic components of the natural environmental system and the stability of the environment and ecological balance largely depend on the status of the forests of the region concerned.

It is a matter of serious concern that the present economic man has forgotten the environment and ecological significance of natural vegetations mainly forests and grasslands and has destroyed the forests so rapidly and alarmingly that the forest areas at global, regional and local levels have so markedly decreased that several serious environmental problems such as accelerated rate of soil loss through rain splash, sheet wash, rill and gully erosion, increase in the frequency and dimension of floods, greater, incidence of drought due to decrease in precipitation etc. have plagued the modern human society. The major causes of deforestation at global and regional levels are conversion of forest land into agricultural land, shifting cultivation, transformation of forests into pastures, overgrazing, forest fires, lumbering, multipurpose river projects etc.

4. Agricultural Development:

Agricultural development means expansion of agricultural land increase in agricultural productivity and net agricultural production. It is due to development of modern scientific techniques, advanced technologies, increased production and use of chemical fertilizers, expansion in irrigational facilities, development of high yielding varieties of seeds, etc. This has solved the problem of growing demand of food due to ever increasing world population on the one hand; it has also created or is creating hazardous environmental problems of serious concern on the other hand. Thus modern economic and technological man is at the cross road of dangers in all directions.

The agricultural development degrades the environment in a variety of ways, *e.g.* (i) through the application of chemical fertilizers and pesticides and insecticides, (ii) through the increase in irrigational facilities and amount of irrigation, (iii) by making changes in biological communities etc.

Conversion of forests land into agricultural farms on sloppy ground accelerates rate of soil erosion. Increased in agricultural land at the cost of destruction ol forest and consequent soil erosion, substantial increase in the productivity of land through the practice of intensive cultivation, increased use of machines and modern scientific techniques, application of chemical fertilities, pesticides, insecticides and herbicides, increase in the frequency and area of watering of agricultural fields, etc. All these processes and measures of increased agricultural development cause several serious environmental problems. It appears that the root cause of all these environmental problems arising out of agricultural development is the increase of human population at alarming rate. So the foremost step to be taken is to stop population growth because if population continues to grow agricultural development has to be maintained.

5. Industrial Development:

Rapid industrial development has given economic prosperity to human society. It has also given new dimension to socio-economic structure and has provided material comfort to the people of industrially developed countries but it has also created many fold environmental problems. In fact, the glittering effects of industrialization have affected the mind of the general public that industrialization is now being considered as the parameter of modernity and as a necessary element of socio-economic development of a nation. Rapid rate of industrialization resulted into rapid rate of exploitation of natural resources and increased industrial output. Both the components of industrial development e.g. exploitation of natural resources and industrial production have created several lethal environmental problems and have caused large scale environmental problems and ecological imbalance at global, regional and local levels in a variety of ways. Exploitation of natural resources in order to meet the industrial demand of raw materials has resulted into (i) the reduction of forest covers due to reckless falling of trees, (ii) excavation of land for mining purposes, (iii) reduction in arable land due to industrial expansion, (iv) lowering of groundwater level due to excessive withdrawal of groundwater, (v) collapsing of ground surface due to withdrawal of mineral oil and groundwater etc.

Besides desired production there are numerous undesired outputs from the factories such as industrial wastes, polluted water, toxic gases, chemical precipitates, aerosol ashes and smokes etc. which pollute air, water, land, soils etc., and thus degrade the environment. The industrialized countries have increased the concentration of pollutants emitted from the factories in the air, water and land to such an extent that they have degraded the environment to the critical limit and have brought the human society on the brink of its destruction. The adverse effects of industrialization may change the overall character of natural system and the chain effects sometimes become suicidal for human society. Majority of the impacts of industrialization are related to pollution and environmental degradation. The release of toxic elements into the environment through the application of chemical fertilizers, pesticides and insecticides (output of chemical industries) changes the food chains and food webs and physical and chemical properties of soils. Similarly the release of industrial wastes into stagnant waters of ponds, tanks, and lakes into rivers and seas contaminates water and causes several diseases and deaths of organism and thus disturbs ecological balance of aquatic ecosystem.

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BIOLOGICAL WARFARE

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Introduction:

Biological and toxin weapons are either microorganisms like virus, bacteria or fungi, or toxic substances produced by living organisms that are produced and released deliberately to cause disease and death in humans, animals or plants. Biological agents like anthrax, botulinum toxin and plague can pose a difficult public health challenge causing large numbers of deaths in a short amount of time. Biological agents which are capable of secondary transmission can lead to epidemics. An attack involving a biological agent may mimic a natural event, which may complicate the public health assessment and response. In case of war and conflict, high-threat pathogens laboratories can be targeted, which might lead to serious public health consequences (WHO, 2011).

Biological warfare, also known as germ warfare, is the use of biological toxins or infectious agents such as bacteria, viruses, insects, and fungi with the intent to kill, harm or incapacitate humans, animals or plants as an act of war (WHO, 2011). Biological weapons (often termed "bio-weapons", "biological threat agents", or "bio-agents") are living organisms or replicating entities (i.e. viruses, which are not universally considered "alive"). Entomological (insect) warfare is a subtype of biological warfare (wikipedia.com).

Deployment of biological weapons against people, their crops and animals. Bioterrorism is the international or threatened use of viruses, bacteria, fungi or toxins from living organisms to produce death or diseases in humans, animals and plants. Pathogens Small pox virus, Viral encephalitides, Viral haemorrhagic fevers, Bacillus anthracis, Brucella suis, Coxiella brunetti, Francisella tularensis, Yersinia pestis, Toxins Botulinum, Ricin, Stylococcal enterotoxin B Anticropagents Rice blast, Rice stem rust, wheat stem rust. Bioweapons are more destructive than chemical weapons including nerve gas, similar to the extent of a nuclear explosion; a few kg of anthrax can kill as many people as a Hiroshima size nuclear bomb (pw.live). A biological attack could conceivably result in large numbers of civilian casualties and cause severe disruption to economic and societal infrastructure (Koblentz, 2004).

As a tactical weapon for military use, a significant problem with biological warfare is that it would take days to be effective, and therefore might not immediately stop an opposing force. Some biological agents (smallpox, pneumonic plague) have the capability of person-to-person transmission via aerosolized respiratory droplets. This feature can be undesirable, as the agent(s) may be transmitted by this mechanism to unintended populations, including neutral or even friendly forces. Worse still, such a weapon could "escape" the laboratory where it was developed, even if there was no intent to use it – for example by infecting a researcher who then transmits it to the outside world before realizing that they were infected. Several cases are known of researchers becoming infected and dying of Ebola (Borisevich *et al.,* 2006; Akinfeyeva *et al.,* 2005).

The history of biological warfare:

World War I

By 1900 the germ theory and advances in bacteriology brought a new level of sophistication to the techniques for possible use of bio-agents in war. Biological sabotage in the form of anthrax and glanders was undertaken on behalf of the Imperial German government during World War I (1914–1918), with indifferent results.(wikipedia.com)(Koenig, 2006)

World War II

With the onset of World War II, the Ministry of Supply in the United Kingdom established a biological warfare program at Porton Down, headed by the microbiologist Paul Fildes. The research was championed by Winston Churchill and soon tularemia, anthrax, brucellosis, and botulism toxins had been effectively weaponized. In particular, Gruinard Island in Scotland, was contaminated with anthrax during a series of extensive tests for the next 56 years. Although the UK never offensively used the biological weapons it developed, its program was the first to successfully weaponize a variety of deadly pathogens and bring them into industrial production.(wikipedia.com; Prasad, 2009). Other nations, notably France and Japan, had begun their own biological weapons programs (wikipedia.com; Garrett, 2003).

During the final months of World War II, Japan planned to use plague as a biological weapon against U.S. civilians in San Diego, California, during Operation Cherry Blossoms at Night. The plan was set to launch on 22 September 1945, but it was not executed because of Japan's surrender on 15th August 1945 (Baumslag, 2005; GlobalSecurity.org, 2014; Stewart, 2011; Working, 2001).

Cold War

In Britain, the 1950s saw the weaponization of plague, brucellosis, tularemia and later equine encephalomyelitis and vaccinia viruses, but the programme was unilaterally cancelled in 1956. The United States Army Biological Warfare Laboratories weaponized anthrax, tularemia, brucellosis, Q-fever and other (wikipedia.com; Clark, 2008).

1948 Arab–Israeli War

According to historians Benny Morris and Benjamin Kedar, Israel conducted a biological warfare operation codenamed "Cast Thy Bread" during the 1948 Arab–Israeli War. The Haganah initially used typhoid bacteria to contaminate water wells in newly-cleared Arab villages to prevent the population including militiamen from returning. Later, the biological warfare campaign expanded to include Jewish settlements that were in imminent danger of being captured by Arab troops and inhabited Arab towns not slated for capture. There was also plans to expand the biological warfare campaign into other Arab states including Egypt, Lebanon and Syria, but they were not carried out (Morris *et al.*, 2022).

International restrictions on biological warfare began with the 1925 Geneva Protocol, which prohibits the use but not the possession or development of biological and chemical weapons in international armed conflicts (Baxter and Buergenthal, 2017; en.wikipedia.org). The Centers for Disease Control and Prevention (CDC) define bioterrorism Trusted Source as “the intentional release of viruses, bacteria, or other germs that can sicken or kill people, livestock, or crops.(wikipedia.com).

Soldier with protective dressing

During the past century, more than 500 million people died of infectious diseases. Several tens of thousands of these deaths were due to the deliberate release of pathogens or toxins, mostly by the Japanese during their attacks on China during the Second World War. Two international treaties outlawed biological weapons in 1925 and 1972, but they have largely failed to stop countries from conducting offensive weapons research and large-scale production of biological weapons. And as our knowledge of the biology of disease-causing agents—viruses, bacteria and toxins—increases, it is legitimate to fear that modified pathogens could constitute devastating agents for biological warfare. To put these future threats into perspective, I discuss in this article the history of biological warfare and terrorism (www.ncbi.nlm.nih.gov).

Anthrax:

Experts believe that today, the most likely organism to be used in a bioterrorism attack would be Bacillus anthracis, the bacteria that causes anthrax. It is widely found in nature, easily produced in the laboratory, and survives for a long time in the environment. Also, it is versatile and can be released in powders, sprays, water, or food. Anthrax has been used before. In 2001, anthrax spores were sent through the United States postal system. In all, 22 people contracted anthrax — five of whom died. And, the guilty party was never caught (medicalnewstoday.com).

Smallpox:

Another potential agent of bioterrorism is smallpox Trusted Source, which, unlike anthrax, can spread from person to person. Smallpox is no longer a disease of concern in the natural world — because concerted vaccination efforts stamped it out — and the last naturally spread case occurred in 1977 (medicalnewstoday.com).

Plague:

We have already mentioned the Tartars' use of the plague, Yersinia pestis, hundreds of years ago, but some believe that it could be used in the modern world, too. Y. pestis is passed to humans through the bite of a flea that has fed on infected rodents.

Once a human is infected, the resulting disease can either develop into bubonic plague, which is difficult to transmit among humans and fairly easy to treat with antibiotics, or — if the infection spreads to the lungs — it becomes pneumonic plague, which develops rapidly and does not respond well to antibiotics (medicalnewstoday.com).

Cholera:

As a potentially severe and sometimes deadly gastrointestinal disease, cholera has the potential to be used in bioterrorism. It does not spread easily from person to person, so for it to be effective, it would need to be liberally added to a major water source.

In the past, the bacteria responsible for cholera, Vibrio cholerae, has been weaponized by the U.S., Japan, South Africa, and Iraq, among others (medicalnewstoday.com).

Deadly anthrax toxin: A pain-blocking treatment of the future?

A recent study found that anthrax edema toxin, or ET, altered pain responses in mouse and human sensory neurons. Injecting this toxin into the spine of mice blocked pain without systemic effects. The study also showed that modified anthrax protein could serve as a potential delivery vehicle for other pain-blocking substances in the nerves. Determining its safety and effectiveness for treating pain will require more research in animals and human participants (medicalnewstoday.com)

Tests and diagnosis:

Anthrax shares many symptoms with more common conditions, such as flu and pneumonia. A health care provider will rule these out first before considering anthrax, unless there is a specific reason to suspect it. If other conditions are ruled out, then tests specific to anthrax may follow. An anthrax diagnosis can only be confirmed by measuring antibodies or toxins in the blood or other tissue. The type of tissue sample and other types of tests will depend on the suspected form of anthrax.

Tests include:

1. A skin biopsy to test for cutaneous anthrax
2. Stool testing for gastrointestinal anthrax
3. Chest x-rays or CT scans to detect inhalation anthrax
4. Lumbar punctures to reveal anthrax meningitis

In 2014, scientist researched that a “glow test” can detect the presence of deadly anthrax bacteria in hours instead of days. This could significantly cut the time it takes to respond to a potential bioterrorism attack. (medicalnewstoday.com)

Treatment:

Anthrax must be treated as quickly as possible, before the levels of toxins and harmful bacteria within the body become too high for drugs to eliminate.

The standard treatment for anthrax is with antibiotics and antitoxins. The type of antibiotics will depend on how the infection occurred, the individual’s age and medical history.

Antitoxin therapies are currently being developed that target the toxins released by B. anthracis, rather than the bacteria themselves.

Recently, surgical removal of infected tissue has been used successfully to treat injection anthrax.

In 2013, a team of researchers discovered a new chemical compound Trusted Source from the sea that could be used to treat anthrax and MRSA. (medicalnewstoday.com)

Prevention:

Tips for avoiding anthrax include:

only eating meat that has been suitably slaughtered and cooked avoiding contact with raw animal hides, especially those of cows, sheep, and goats. People who work with fur, hides, and wool, especially if these are imported, should take extra care. If anyone is exposed to the bacteria, antibiotics can prevent the symptoms of anthrax from developing before the *B. anthracis* spores have time to activate. The U.S. Food and Drug Administration (FDA) have approved a vaccine for anthrax, to be used prior to exposure by adults who could be at risk. These include laboratory workers, handlers of animals and animal products, and some military personnel. It is not available to the public. The vaccine can also be given after exposure, alongside antimicrobial therapy. Anthrax remains rare in the U.S. If a person has symptoms that resemble anthrax, it is most likely a more common illness. If a person shows signs and symptoms after exposure to animals or animal products from parts of the world where anthrax is common, however, it is best to contact a health care provider.

To be effective, treatment for anthrax must begin as soon as possible. (medicalnewstoday.com)

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EFFECT OF BIOSORBENT QUANTITY ON BIOSORPTION OF DIFFERENT METAL IONS BY *MARSILEA QUADRIFOLIA*

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Abstract:

Heavy metals can be sourced from both natural and anthropogenic influences; in some areas anthropogenic inputs are proportionately greater than those from natural sources. It's without argument higher levels of heavy metals are found in urban landscapes and industrial sites which far exceed natural levels. These can be sourced from a diverse range of origins from roadside vehicle pollution to run off from contaminated land associated with industries. Heavy metal pollutants can localize and lay dormant; unlike organic pollutants they do not decay posing a different approach for remediation. Currently, plants or microorganisms are tentatively used to aid removal of heavy metals like mercury from soils. The effect of biosorbent quantity on the biosorption of metal ions at different biomass concentrations of 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 gm (initial sorbate concentration of 20 mg/l; time 120 min. and pH 5.0 and pH 6.0) showed that the biosorptive efficiency is greatly dependent on the increase in quantity of biosorbent in the solution unless it reaches the equilibrium where constant values of biosorption was obtained. The biosorption of metal ions by different aquatic macrophyte species was found to be directly proportional to the biomass concentration. The optimum values of biosorbent concentration require to cause maximum biosorption metal ions was found to be of 1.5 gm/l, 2 gm/l and 2.5 gm/l *Marsilea quadrifolia* Linn. *Marsilea quadrifolia* Linn. reported with maximum biosorption at dose of 2.5 gm/l of biosorbent (Table 4.4.4 & Fig. 4.4.4) for Zn (II) ion (8.1 mg/g) followed by Cu (II) ion (7.8 mg/g), Pb (II) ion (7.6 mg/g), Al (III) ion (7.1 mg/g) and Ni (II) ion (6.6 mg/g). Highest percent removal for Zn (II) ions (42.19%) and lowest for Ni (II) ions (34.38%) at a biosorbent dose of 2.5 gm/l was observed in *Marsilea quadrifolia* Linn.

Keywords: Heavy metals; *Marsilea quadrifolia*; Biosorption; biosorbent.

Introduction:

Heavy industrialization and anthropogenic activities lead to the discharge of waste and wastewater containing heavy metals to environment. Many industries like mine draining, metal industries, petroleum refining, tanning and electroplating are some of the sources of the heavy metals (Volesky, 2001). Wastewater discharge is often characterized by high flows and high concentrations of sulphate, heavy metals, and other toxic elements as well as low pH (Modis *et al.,* 1998) and can contaminate surface and ground waters as well as the surrounding land

With increasing global population, challenge of providing clean water for communities will be greater in future. The demand of human needs creates huge pressure on limited natural freshwater resources globally. Increased population and rapid industrialization resulted into generation of wastewater discharge into water environment like lakes, rivers, reservoirs etc. which contains mainly non biodegradable heavy metal concentrations along with many other toxic pollutants causing serious hazards to human populations.

There are several methods like chemical precipitation, adsorption, ion exchange, membrane filtration, coagulation-flocculation and floatation for heavy metal removal.

Chemical precipitation is an effective technique for the removal of heavy metals from wastewater. Chemicals used in this process react with heavy metals and formation of insoluble precipitates in wastewaters which is then removed by sedimentation technique with clear water remaining is decanted (Fu and Wang, 2011; Djedidi *et al.*, 2009).

Flotation process is a very well recognized process for the removal of heavy metals (Fu and Wang, 2011) from the wastewater with selective metal ion recovery, minimum generation of sludge and high separation efficiency (Rubio *et al.*, 2002) as an advantage

Ion exchange produces lesser sludge volume with selective metal ion recovery as an advantage of the process and it involves use of different types of natural or synthetic resins (Dorfner, 1991).

Coagulation is a process which uses coagulants and these coagulants are formed by combination of insoluble particle and/or dissolved organic matter into large aggregates

There are different types of membrane filtration techniques based on different kind of membranes. It has several advantages over conventional methods like high separation efficiency and it involves no phase change, easy scaling, saves energy, and environmentally friendly (Zhu *et al.,* 2014). Ultrafiltration (UF), reverse osmosis (RO) and nanofiltration are the techniques used for removal of heavy metals.

Adsorption method is comparatively low-cost process. Adsorption has certain advantages over conventional methods such as they minimize chemical and biological sludge, low cost, high efficiency, regeneration of adsorbents and possibility of metal recovery.

Over all, heavy metal removal from waste waters can be done with utilization of several methods mentioned as above, each of these methods or techniques has its own merits and demerits. Adsorption method is broadly used over conventional methods such as ion exchange, chemical precipitation, coagulation-flocculation membrane filtration and floatation but it also seems to be expensive therefore need of new cost-effective technology in heavy metal removal from waste water pointed towards biosorption a bioremediation technique for the last few decades.

Materials and Methods:

1. Collection of plant material

Aquatic macrophytes *Marsilea quadrifolia* Linn. *were* selected for present study and collected from the river Chandrabhaga near village Mahuli (Dhande) Ta- Daryapur, Dist- Amravati (M.S.).

2. Biosorbents

Dried biomass of collected plant species of aquatic macrophytes *Marsilea quadrifolia* Linn. used for the biosorption study and were tested for their biosorptive capacity for heavy metals selected, such as Copper (Cu), Zinc (Zn), Aluminium (Al), Nickel (Ni) and Lead (Pb). The biosorbents (dead dried biomass) employed in this study were obtained as a whole plant *Marsilea quadrifolia* Linn.

3. Pretreatment of biomass

The collected biomass of aquatic macrophyte species from river water were thoroughly washed with distilled water to remove all the extraneous material and placed on a filter paper to reduce the water content prior to treating the biomass with 0.02 M HNO_3. It was then dried overnight at 50^{o}C until a constant weight was achieved and the final weight of the biosorbent was recorded. The biosorbents were then very well crushed and allowed to passed through a 300 nm sieve in order to obtain uniform particle size of each biosorbent used for further studies.

4. Preparation of heavy metal ions solutions

4.1 Copper solution

For Cu (II), Copper sulphate ($CuSO_4$ $5H_2O$) as a stock solution was prepared by dissolving 3.93 grams of $CuSO_4$ $5H_2O$ (Analytical grade) in 100 ml of double distilled water to make a concentration of 1000 mg/l, and serial dilutions from of this stock solution were prepared to obtain10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 mg/l concentration of Cu (II) ion solution.

4.2 Zinc solution

For Zn (II), a stock solution of Zinc sulphate ($ZnSo_4$ $7H_2O$) was prepared by dissolving 4.397 grams of $ZnSo_4$ $7H_2O$ (Analytical grade) in 100 ml of distilled deionized water to make a concentration of 1000 mg/l, and from this stock solution, serial dilutions were made to obtain 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 mg/l concentrations of Zn (II).

4.3 Lead solution

For Pb (II), a stock solution of Lead nitrate ($N_2\ O_6\ Pb$) was prepared by dissolving 1.598 grams of $N_2\ O_6$ Pb (Analytical grade) in 100 ml of distilled deionized water to make a concentration of 1000 mg/l, and from this stock solution, serial dilutions were made to obtain 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 mg/l concentrations of Zn (II).

4.4 Nickel solution

For Ni (II), a stock solution of Nickel sulphate ($NiSo_4\ 6H_2O$) was prepared by dissolving 4.47 grams of $NiSo_4\ 6H_2O$ (Analytical grade) in 100 ml of distilled deionized water to make a concentration of 1000 mg/l, and from this stock solution, serial dilutions were made to obtain 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 mg/l concentrations of Zn (II).

4.5 Aluminium solution

For Al (III), a stock solution of Alluminiuml sulphate ($Al_2\ (So_4)_3\ 18\ H_2O$) was prepared by dissolving 24.70 grams of $Al_2\ (So_4)_3 18H_2O$ (Analytical grade) in 100 ml of distilled deionized water to make a concentration of 1000 mg/l, and from this stock solution, serial dilutions were made to obtain 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 mg/l concentrations of Zn (II).

5. Methods

5.1 Bisorption studies

5.1.1 Glassware and apparatus

All biosorption experiments and batch mode studies related to biosorptive potential of dried biomass of aquatic macrophytes were performed by using 125 ml Erlenmeyer flasks. The flasks were baked at 70°C for 4 hours prior to use, followed by one wash with concentrated HNO_3 and then with distilled water.

5.1.2 Biosorption evaluation (PLATE IX)

For evaluation of rate of metal ion biosorption by dried biomass, 20 ml of each metal ion (Cu, Zn, Al, Pb and Ni) solutions in 125 ml Erlenmeyer flasks were taken. The values of pH of all the solutions were monitored by pH meter throughout the experiment and adjusted according to the experiment by using 0.2 N HNO_3, 0.1 N NaOH and buffer solutions (KCl-HCl buffer for pH 2, citric acid- sodium citrate buffer for pH 3-5, Na2HPO4-NaH2PO4 buffer for pH- 6-8 and glycine-NaOH buffer for pH 9-10).

Dead dried biomass of *Eichhornia crassipes* (Mart) Solms, *Pistia stratiotes* Linn., *Hydrilla verticillata* (Lf) Royle, *Marsilea quadrifolia* Linn. and *Ipomea aquatica* Forssk each in the amount of 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 gm (0.5gm/l, 1gm/l, 1.5 gm/l, 2gm/l, 2.5 gm/l and 3gm/l, respectively) of dried biomass were introduced in the flasks of the above mentioned metal ion concentrations separately. All the five biosorbents under investigation were also introduced to flasks filled with pure distilled water with no metal ion (control). The flasks were maintained at temperature 25ºC on a rotary shaker (200 rpm) under constant agitation for a period of 3 hours.

The values of pH for the biosorption capacity of dried biomass of aquatic macrophytes for the metal ions considered in the study were optimized by a series of initial experiments and the effect of pH on metal sorption was determined by equilibrating the sorption mixture at different pH values of 2, 3, 4, 5, 6, 7, 8, 9 and10. Finally, studies for all the metal ions biosorption were carried out at obtained pH values with maximum biosorption.

The optimum sorbate (metal ions) and biomass (dried biomass of aquatic macrophytes) were also optimized and finally, subsequent studies relating to all metal ion solutions were performed at 20 mg/l of sorbate concentrations. The biosorbents (dried biomass of aquatic macrophytes) under investigation were used in the concentration of 1 gm/l for all metal ions unless otherwise mentioned. All the studies were carried out at 30°C for 120 min. after optimizing the temperature and time required for sorption of all metal ions considered in the study.

2.6 Analysis by Atomic Absorption Spectrometer (AAS)

All the samples were tested for metal ion concentration by using Atomic Absorption Spectrometer at Department of Biotechnology, North Maharashtra

Results and Discussion:

The effect of biosorbent quantity on the biosorption of metal ions at different biomass concentrations of 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 gm (initial sorbate concentration of 20 mg/l; time 120 min. and pH 5.0 and pH 6.0) showed that the biosorptive efficiency is greatly dependent on the increase in quantity of biosorbent in the solution unless it reaches the equilibrium where constant values of biosorption was obtained.

The biosorption of metal ions by different aquatic macrophyte species was found to be directly proportional to the biomass concentration. The optimum values of biosorbent concentration require to cause maximum biosorption metal ions was found to be .5 gm/l by *Marsilea quadrifolia* Linn., respectively

Marsilea quadrifolia Linn. reported with maximum biosorption at dose of 2.5 gm/l of biosorbent (Table 1 & Fig. 1) for Zn (II) ion (8.1 mg/g) followed by Cu (II) ion (7.8 mg/g), Pb

(II) ion (7.6 mg/g), Al (III) ion (7.1 mg/g) and Ni (II) ion (6.6 mg/g). Highest percent removal for Zn (II) ions (42.19%) and lowest for Ni (II) ions (34.38%) at a biosorbent dose of 2.5 gm/l was observed in *Marsilea quadrifolia* Linn.

Table 1: Effect of biosorbent quantity on biosorption of different metal ions by *Marsilea quadrifolia* Linn..

Biosorbent quantity (gm)	***Cu***		***Ni***		***Al***		***Zn***		***Pb***	
	qe (mg/g)	**% removal**	**qe (mg/g)**	**% removal**	**qe (mg/g)**	**% removal**	**qe (mg/g)**	**% removal**	**qe (mg/g)**	**% removal**
0.5	3.2	16.49	4.6	23.96	4.1	21.24	5.4	28.13	5.4	27.84
1	3.5	18.04	4.9	25.52	4.5	23.32	6.5	33.85	6.2	31.96
1.5	4.2	21.65	5.8	30.21	5.7	29.53	7.1	36.98	6.9	35.57
2	6.1	31.44	6.1	31.77	6.3	32.64	7.4	38.54	7.3	37.63
2.5	7.8	40.21	6.6	34.38	7.1	36.79	8.1	42.19	7.6	39.18
3	6.8	35.05	6.2	32.29	6.5	33.68	7.3	38.02	7.2	37.11

C'_0 = 20 mgm/l; initial estimated Cu concentration, C_0 = 19.4 mgm/l.

C'_0 = 20 mgm/l; initial estimated Ni concentration, C_0 = 19.2 mgm/l.

C'_0 = 20 mgm/l; initial estimated Al concentration, C_0 = 19.3 mgm/l.

C'_0 = 20 mgm/l; initial estimated Zn concentration, C_0 = 19.2 mgm/l.

C'_0 = 20 mgm/l; initial estimated Pb concentration, C_0 = 19.4 mgm/l.

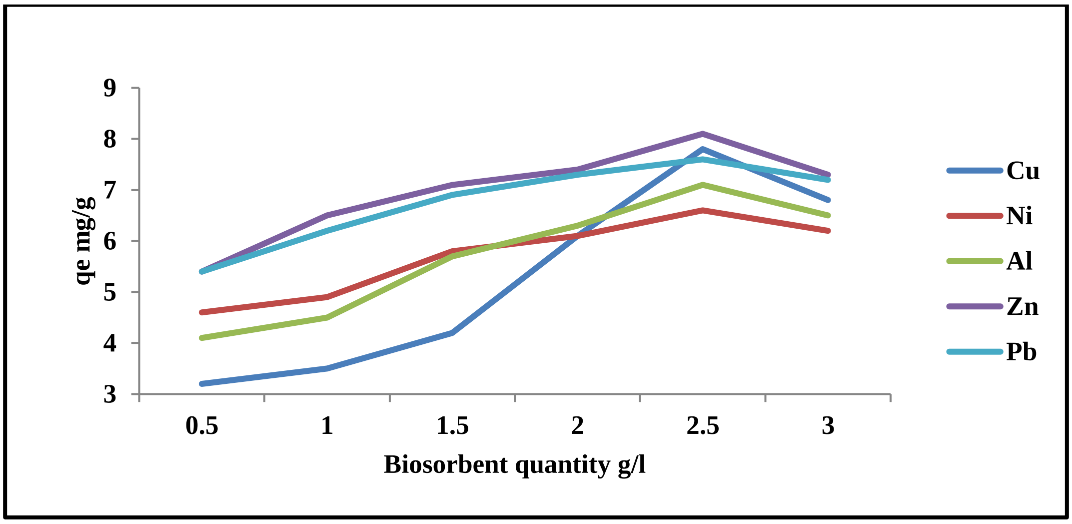

Figure 1: Effect of biosorbent quantity on biosorption of different metal ions by *Marsilea quadrifolia* Linn.

Conclusion:

The purpose of the present study was to find out the biosorption capacity of five aquatic macrophyte plant species namely *Eichhornia crassipes* (Mart) Solms, *Pistia stratiotes* Linn., *Hydrilla verticillata* (Lf) Royle, *Marsilea quadrifolia* Linn. and *Ipomea aquatica* Forssk collected from river water for phytoremediation of heavy metals. These aquatic macrophyte plant species (dead biomass) were taken under investigations for the removal of toxic metal ions, such as Cu (II), Zn (II), Ni (II), Al (III) and Pb (II) ions in order to propose low cost eco-friendly biosorbents for waste water treatment. The findings were based on biosorption capacity, equilibrium modeling and kinetic studies. Experiments were performed as a function of initial metal ion concentration, initial solution pH, biosorbent dosage, temperature and contact time, etc. The solution pH, temperature and initial metal ion concentration played a significant role in affecting the capacity of biosorption. The optimized values of the above parameters were obtained on performing batch mode studies. Based on the observations and results on equilibrium data of biosorption of metal ions by macrophyte plant species

Biosorptive capacity for metal ions Cu (II), Zn (II), Ni (II), Pb (II) and Al (III) by aquatic macrophyte species *Marsilea quadrifolia* Linn.which was recorded with combination of both 30^{o}C and 40^{o}C temperature for Cu (II), Zn (II) ions and Ni (II), Pb (II), Al (III) ions respectively.

Thus, the present study concludes that *Marsilea quadrifolia* may employ as an economic and environment friendly biosorbents and can be a good option to the expensive methods currently used in removing metals from polluted water.

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