CHAPTER 7

BOTANY

Doctoral Theses

01. AABHA
Using Structural and Functional Genomics to Identify Avirulence Factors in Fusarium Wilt Disease of Safflower.
Supervisor: Prof. Manu Agarwal
Th 27202

Abstract

Carthamas tinctorious L. (Safflower) a member of family Asteraceae is, cultivated mainly for its seeds, which are a source of highly nutritious edible oil. The oil extracted from the Safflower seeds is rich in oleic and linolenic acids, which reduces bad cholesterol in blood and are considered beneficial for the cardiac health. Safflower florets are also used for the extraction of red/orange dye used as an additive in foods. In India, the area of Safflower cultivation has constantly declined over the last two decades and one of the primary reasons has been the shifting of farmers to economically better crops. Nevertheless, as Safflower has a very low water requirement, it is still extensively grown in semiarid regions of Maharashtra, Telangana and Andhra Pradesh. One of the major impediments for realizing the yield potential in Safflower is it's susceptibility to fungal pathogens like Alternaria and Fusarium. The wilt disease in Safflower is caused by Fusarium oxysporum f.sp. carthami (Foc) and for sustainable cultivation of Safflower, development of resistant varieties is of paramount importance. In an effort to identify the crucial avirulence factors we deployed comparative genomic and transcriptomic study during compatible and incompatible interaction of Foc with susceptible and resistant accession of safflower. We also focused to decipher the molecular mechanism through which syringic acid provides resistance to susceptible accession. We believe the information gained through current study will not only lead to isolation of the avirulent factors of Safflower, but will also help in expanding the knowledge base of plant fungus interaction in general.

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02. AJAY KUMAR
Genetic Mapping of Resistance to *Albugo* Candid in Brassica *Rapa*.
Supervisor: Dr. Priya Pajabi
Th 26999

Abstract

White rust, caused by *Albugo candida* (Pers. ex Lev.) Kuntze, is a major disease of *Brassica* species, including oilseed crops, *B. juncea* (Indian mustard) and *B. rapa*. Plant pathogens belonging to the genus *Albugo* infect more than 400 host plants from different (~31) families (Biga, 1995; Choi and Priest, 1995). Of these, the species *A. candida* is pathogenic to crucifer plants (both oilseed and vegetable types). The pathogen is known to infect more than 241 species belonging to more than 60 genera of Cruciferae (Saharan and Verma, 1992; Biga, 1995; Choi and Priest, 1995).*A. candida* is an oomycete filamentous fungus that is considered to have descended from a non-fungal aquatic ancestor and belongs to the kingdom, Stramenopiles (Saharan and Verma, 1992). The fungus penetrates the host tissue through the stomata of the leaf via germ tubes and colonizes mesophyll cells (Holub et al., 1995). The disease symptoms are manifested in the form of white-colored pustules on the cotyledons, leaves, stems and pods. Severe infection results in extensive distortion,hypertrophy and hyperplasia leading to the sterility of inflorescence (stagheads). *Helianthus annuus* L. plants were grown in soil spiked with chromium (VI) having three different concentrations (15, 30 and 60 mg kg-1 of soil) of Cr(VI) to study Cr-toxicity and effects of exogenous Titanium dioxide nanoparticles (TiO2 NPs) and green titanium dioxide nanoparticles (gTiO2 NPs). All three concentration of Cr(VI) was used in first experiment, Cr(VI) +TiO2 NPs (15 ppm) in second experiment, and Cr(VI) +TiO2 NPs and Cr(VI) + gTiO2 NPs (15 ppm) in third experiment was exogenously sprayed on 20-days-old plants, thrice with a gap of 3 days to check for various parameters like Cr(VI)-accumulation, plants growth, photosynthesis, oxidative stress, AsA-GSH cycle, PCs content, and DNA damage. Results of first experiment revealed that Cr(VI) was accumulated in root and shoot, which significantly ($p \leq 0.05$) posed toxicity on morphological and growth parameters. Cr(VI) intensifies H2O2 and MDA production. Toxicity on photosynthesis is resulted due to inhibition in stomatal (A, E, GH2O) and non-stomatal. Results of second experiment showed that TiO2 NPs reduced Cr(VI) uptake in roots and shoots, up-regulation AsA-GSH cycle, which protects vital metabolic processes in plants like photosynthesis, DNA damage, and chelate HMs. The Cr(VI) effectively induces PCs biosynthesis in both root and leaf of *H. annuus* L. Importantly, TiO2 NPs positively regulated PCs synthesis under non-stress and negatively regulated under stress conditions. Results of third experiment showed mechanisms by which TiO2NPs and gTiO2NPs alleviated Cr(VI) accumulation in roots and shoots of *H. annuus* L., which result in loss of H2O2 and MDA content and lesser cellular DNA damage. TiO2NPs and gTiO2NPs up regulate AsA-GSH cycle. This study mainly confirmed that gTiO2NPs perform better than synthetic TiO2NPs at morphological, physiological and biochemical level to alleviate Cr(VI) induced toxicities on *H. annuus* L. It could be due to compatibility with biological system.

Contents

03. ANAND (Rashi)
Molecular Insights into Rice-Planthopper Interaction.
Supervisor: Prof. Sudeshna Mazumdar-Leighton
Th 27203

Abstract

The co-evolutionary conflict between plants and insects has shaped intricate evolutionary systems characterized by both partners' dynamic defence and adaptive mechanisms. The challenge of protecting crops from destructive insects has escalated as pests continually outpace conventional pest control methods.

This thesis focuses on the adaptive strategies adopted by two significant rice pests, i.e., brown planthopper [BPH, Nilaparvata lugens] and white backed planthopper [WBPH, Sogatella furcifera], which continuously overcome host-plant resistance through mechanisms beyond the conventional "gene-for-gene" paradigm. This investigation unravels the molecular dynamics of the interaction between the planthoppers and rice to develop sustainable pest management strategies. This study consists of two parts. First, the genetic diversity of BPH populations across nine distinct rice-growing regions in India is explored. By employing DNA-based markers derived from the Control Region of BPH mitogenome, we successfully distinguished BPH populations and uncovered migration patterns likely influenced by monsoon winds. Further, southern BPH populations emerge as potential sources for northern populations, providing crucial insights for devising effective management strategies for BPH. Second, utilizing Next-Generation Sequencing and quantitative real-time PCR (qRT-PCR), this study comprehensively characterized the transcriptomes of both hoppers during their interactions with rice recombinant inbred lines exhibiting differential resistance to these pests. This analysis identified essential genes and functional pathways implicated in counter-defence mechanisms in these hoppers against host resistance. Further, these findings highlight underlying molecular responses to host-plant resistance, thereby identifying promising avenues for developing sustainable pest-resilient rice varieties. In conclusion, valuable insights were gained from these studies into host-plant resistance and insect adaptation mechanisms against host resistance. These contribute to formulating targeted pest management strategies, facilitating enhanced crop productivity and reducing dependence on chemical interventions. Ultimately, this work aligns with the universal goals of pursuing sustainable agricultural practices and long-term global food security in the face of persistent insect attacks**.**

Contents

04. BABUTA (Priyanka)
Genome Wide Identification of S-Nitrosogluthione Reductase (GSNOR) & NAPDH-Dependent Thioredoxin Reductase (NTR); and Characterization of GSNOR from *Brassica Juncea*.
Supervisor: Prof. Renu Deswal
Th 27000

Abstract

S-ntrosylation is a well-known post-translational modification that modulates nitric oxide (NO) dependent cll signaling. S-nitrosoglutathione reductase (GSNOR) and NADPH- dependent thioredoxin reductase (NTR) are essential for nitric oxide/S-nitrosothiol homeostasis. GSNOR and NTR egulate denitrosylation by reducing S-nitrosoglutathione and thioredoxins, respectively. Genome-wide identification yielded 4 GSNOR and 12 NTR (4 each of NTRA, NTRB, and NTRC) genes in Brassica juncea. Multiple gene copies are attributed to genome triplications and hybridiz ation events during the evolution of Brassicas. Promoter and structural analysis suggested diferential reguletion. Interestingly subcellular localization of BGSNOR was predicted not only to cytosol but also to Golgi apparatus and endoplasmic reticulum. Both enzymes showed modulation in activity by light, phytohormones and stress. PCR amplification of 4 genes 1.9,2.0,2.1, and 2.4kb) and 2 cDNA amplicons (1.1 and 1.2kb) confirmed multiple

GSNOR genes in B. juncea. Interestingly, in-gel GSNOR activity showed 2 bands on nondenaturing PAGE. Also, GSNOR immunoblot revealed 2 immunopositive polypeptides which resolved into 4 immunopositive spots at 41.5 kDa (pl 5.79 and 6.78) and 43 kDa (pl 6.16 and 6.23). This confirmed multiple forms of GSNOR at protein level which were further characterized by purification of GSNOR from B. juncea. Interestingly, 2 pools (GSNOR-A & GSNOR-B) with GSNOR activities were obtained after anion-exchange chromatography. Further, affinity-base purification resulted in 1 polypeptide (41.5kDa) GSNOR-A and 2 polypeptides (41.5kDa and 43kDa) from GSNOR-B. Size exclusion-HPLC analysis confirmed 3 GSNOR proteins with native molecular weight of 87.48 KDa in GSNOR-A and 87.36 kDa and 82.74 kDa in GSNOR-B.Km and V max of 118 t11uM and 287+22 nkat/mg for GSNOR-A and 96.4+8uM and 349+15 nkat/mg for GSNOR-B was obtained by Kinetic analysis. Both fractions showed high thermostability, concentration dependent inhibition with dedacanoic acid and NO-based redox regulation. To the best of our knowledge, this is the first report to confirm multiple isoforms of GSNOR in B. juncea.

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05. CHAHAR (Nishu) Nee Nishu
Ovate Family Protein (OFP): Evolutionary Analysis across Plants and, Functional Characterization of Non-Canonically Organized Genes and Associated Bidirectional Promoters from *Arabidopsis Thalina*.
Supervisor: Prof. Sandip Das
Th 27001

Abstract

Ovate Family Proteins (OFPs) are now known as a family of transcriptional regulators,that are distributed along all plant lineages (except in algal lineages analysed thus far). The protein is nuclear-localized in agreement with their role as transcriptional regulator and are characterized by a ~70 aa conserved region at C-terminal. The functional significance of the conserved region was demonstrated when the loss of this conserved region because of premature termination codon resulted in conversion of round fruit to pear-shaped or Ovate shaped fruit in tomato. The conserved region was thus annotated as OVATE domain and is signature or characteristic feature of all homologs. Experimental evidences indicate the role of OFP in mediating growth, development of various organs and tissues such as cotyledon, secondary cell wall, floral organ; cell division and elongation, ovule development and pollen functionality; and in abiotic stress response with hormonal homeostasis. Detailed functional characterization of a handful of OFP genes have been performed thus far from only selected species where OFP have been reported to interact with other transcription factors such as MADS-box, GRAS-, KNOX-, and BELL-homeodomain proteins, and, participate in signal transduction through interaction with kinases such as GSK3-like, GS9, OsBIN2. Owing to a limited number of studies, organisation of OFP in the genome, evolutionary history, transcriptional regulation and role in several developmental pathways are still not known. Brassicaceae is large plant family with world-wide distribution of species valued for their agronomic, economic and medicinal significance in the form of vegetables, fibres, food, vitamins, minerals, soluble sugars, phenolic compounds, glucosinolates and edible oils. *Brassica* is the second most productive crop in India in terms of area under vii cultivation, and yet the oil seed production and yield are insufficient to meet the supplydemand gap of oilseeds. *Arabidopsis thaliana* is a model dicot from Brassicaceae, and valued for its importance in gaining insights into plant developmental pathways. The

knowledge gained can then be extrapolated and translated into crop plants with complex and large genomes such as *Brassica*. In *A. thaliana*, the OFP gene family has nineteen members and functional characterization revealed their redundant roles. Most of them are found to be involved in regulation of organ shape through directional cell division. Over-expression of *AtOFP1, AtOFP2, AtOFP4, AtOFP5* and *AtOFP7* showed redundant phenotype with kidney shaped cotyledons and curled leaves. Detailed functional analysis of *AtOFP2* and *AtOFP5* revealed their interaction with TON2 (TONNEAU 2) which encodes a microtubule regulating protein and their altered expression pattern was found to affect light and brassinosteroid (BR) mediated regulation of microtubule orientation. Except these few studies, complete cataloguing of OFP homologs in Brassicaceae, sequence and structural variations arising during course of evolution, origin of complex organization, transcriptional regulation via bi-directional promoter and functional characterization of OFPs to unravel their role in development is still unknown.

Contents

1. Introduction 2. Review of literature 3. Materials and methods 4. To perform comparative genomics and evolutionary analysis of ovate family (OFOs) gene family in Brassicaceae 5. Origin and evolution of non-canonical organisation of OFP2-PFP17 and OFPA-OFP20 cluster across archaeplastida 6. Sequence analysis of AtOFP promoters, and functional characterization of bi-directional promoters associated with AtOFP2-AtOFP17 and AtOFP4-AtOFP20 gene cluster 7. Functional characterization of AtOFP2 and AtOFP17 in Arabidopsis thaliana 8. Discussion 9. Summary, conclusion and future perspectives. References. Appendices. List of publications and conferences.

06. CHANU (Sougrakpam Yaiphabi)
Myrosinases In Indian Mustard, *Brassica Juncea*.
Supervisor: Prof. Renu Deswal
Th 27002

Abstract

Indian mustard, Brassica juncea is an important oilseed crop. Seeds, seedlings and leaves have high content of phytochemicals mainly, glucosinolates. Isothiocyanate byproduct of sinigrin by myrosinase have anti-carcinogenic properties. A proteomic and immuno-chemical approach was used to study myrosinases in B. juncea. Seeds have 75, 70 and 64 kDa polypeptides with 64 KDa contributing 70% of the total myrosinase polypeptides. Activity increase with growth in seedling with maximum activity at 9-day which corresponded with an increase in abundance of 64 kDa. Differential distribution of myrosinases were observed in different parts of seedlings and in mature (vegetative and flowering) plants. Multiple heterodimeric myrosinases with 64 and 62 kDa subunits were purified from seeds (SD, 130 kDa) and seedlings (SLA & SLB, 150 kDa) with pls 5.3-6.7 using DEAE, HIC and con A chromatography. Purified myrosinases were active at pH 4.5-9.0 and were thermostable. Ascorbic acid induces maximum activation at 400 uM with upto 34-fold activation. Myrosinase 64 kDa is the most dynamic form existing as active dimers, trimers, tetramers, complex and inactive forms which differed in ionic and hydrophobic properties. Active complex and dimeric form of myroinases are present in apoplast. Nuclear myrosinases consisted of soluble trimer of 64 kDa and membrane associated form of 70 KDa. Mlyrosinases (64kDa) form active complex with alpha-mannosidases and MBPs. Interactome analysis suggested potential role in biosynthesis of glucosinolates, their by-product formation and auxin synthesis. Multiple S-nitrosylated myrosinases are present which seems to differ in number of cysteines susceptible to nitric oxide (NO). Soluble trimeric form of myrosinases in nucleus gets nitrosylated. Presence of multiple forms of active myrosinases in different sub-cellular compartments suggested multifunctionality of the enzyme.

The present investigation has provided several leads regarding different forms and localization of myrosinases.

Contents

1. Introduction 2. Review of literature 3. Material and methods 4. Result and discussion 5. References Appendix. List of publications/Conferences.

07. CHAUDHARY (Hina)
Heavy Metal Adsorption and Amelioration of Soil Properties by Biochar Produced From Different Urban Bio Waste Materials.
Supervisor: Prof. K.S. Rao
Th 26553

Abstract

Understanding the appropriate utilization and evaluation of biowaste materials in any global metropolis is crucial for reducing environmental pollution. Heavy metal is a prior concern for the environment and public health which are toxic at low concentrations. Conventional methods for eliminating pollutants are costly, time-consuming, and inefficient. In recent years, biochar production from organic waste has become a popular waste management and environmental remediation method. This study evaluated the physico-chemical, structural, and adsorption properties of biochar produced from biowaste materials collected from Delhi, viz., sugarcane bagasse (SB), brinjal stem, (BS), and citrus peel (CP) pyrolyzed at 450 and 600 °C for 30 and 60 min, respectively, in the muffle furnace and tin kiln. At varying pyrolysis conditions, BS and CP yielded 31-40% biochar, whereas SB yielded 18-39%. Pyrolysis temperatures affected biochar`s characteristics over residence time. TGA, FTIR, and XRD analysis showed that biochar produced at 600 °C had more thermal stability, functional groups, and mineral compositions. Biochar with the desired properties for sustainable agricultural remediation was produced in the following order: BS > CP > SB. This research evaluated biochar`s HM reduction potential in intently polluted soilrite; Pb, Cu, and Cd stabilized, whereas Cr solubilized. Soil quality was improved by the application of biochar derived from SB and BS. Moreover, CP-derived biochar reduced the HMs (Pb, Cr, Cd, Ni) availability in silt loam soil by enhancing the soil pH, EC, and CEC in both production methods. Biochar produced from urban biowaste showed high nutrients (Na+, K+, Pava, Ca, Mg, Mn) that could be used for nutrient-deficient soil in the following order: SB > CP > BS. This study suggests that biochar produced from urban biowaste might help manage biowaste in metropolitan areas while benefiting the environment. However, biochar addition should be thoroughly considered before being used as a remedial approach.

Contents

1 Introduction 2. Review of literature 3. Study area 4.Characterization of biochar produced from different urban bio waste materials through various methods 5. Adsorption performance of biochar in an aqueous system 6. Adsorption isotherms and sorption mechanism in biochar in aqueous system 7. Effect of biochar on heavy metal availability in artificially contaminated soil 8. Effect of biochar on the physic chemical and biological properties of agricultural soil along the Yamuna river in Delhi 9. Summary and conclusion. References, Appendices and List of publications/ Conferences

08. CHAURASIA (Meenakshi)
Impact of Land Use on Soil Carbon and Nitrogen Status in Peri Urban Landscape.
Supervisor: Prof. K.S. Rao
Th 26554

Abstract

Rising population and urbanization accompanied by the expansion of urban spatial structure and the urban form have brought about drastic transformations in land use patterns and thereby are the key drivers of urban ecology. Peri-urban regions at the rural-urban interface are of specific concern because of their dynamic and complex land use pattern which negatively affect soil properties and processes. The present study was conducted in the peri-urban landscape of Ghaziabad to impact of urban land use classes namely agriculture (AGR), park (PAR), residential (RES), industrial and bare land (BAR) to assess the spatial variation of soil physico-chemical and microbiological properties. Soil physico-chemical properties exhibited wide spatial variability. IND was differentiated from other anthropogenic land use by high bulk density. RES was separated from other overlapping land use types by high water holding capacity and Ca concentration. Soil physicochemical properties and microbiological properties i.e., basal respiration (BR), microbial biomass (MBC) and enzyme activities greatly varied across the five land use classes. Among all the land use types, the RES had highest soil organic carbon (SOC), total nitrogen (TN) and mineral nitrogen (1.33%, 0.13%, 84.0 mg kg-1, respectively). While, the BR, MBC, microbial quotient (QCO2), soil microbial activity (SMA) and dehydrogenase activity (DHA) (9.90 C µg g-1 h-1, 300 µg g-1, 0.045 µg h-1/ µg MBC, 9.0 µg ml-1, 1.30 TPF g-1 h-1, respectively) were highest under PAR. Soil CO2 efflux and C mineralization were higher in RES and PAR compared to other land use types. The SOC and TN stock and NO3-N content were highest in RES and lowest in PAR. The NH4-N, MBC and MBN content was maximum in the PAR and lowest under BAR. Among the four anthropogenic land uses PAR had the highest MBC/SOC and MBN/TN. The net N mineralization rate in the studied soil varied from 7.06 to 51.2 µg g-1 month-1 and ammonification rate ranged from 0.57 to 36.0 µg g-1 month-1 and was comparably higher under PAR and RES. Nitrification rate varied from 0.65 to 26.5 µg g-1 month-1 and was highest in AGR. Overall data analysis suggests that anthropogenic land uses can significantly alter soil quality.

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09. DHARMENDRA KUMAR

Studies on Physiological and Biochemical Effects of Exogenously Applied Titanium Dioxide Nanoparticles (TiO_2 NPs) on Sunflower (Helianthus *annuus* L.) Grown Under Chromium (VI) Stress.

Supervisor: Dr. Chandra Shekhar Seth

Th 26555

Abstract

Helianthus annuus L. plants were grown in soil spiked with chromium (VI) having three different concentrations (15, 30 and 60 mg kg-1 of soil) of Cr(VI) to study Cr-toxicity and effects of exogenous Titanium dioxide nanoparticles (TiO2 NPs) and green titanium dioxide nanoparticles (gTiO2 NPs). All three concentration of Cr(VI) was used in first experiment, Cr(VI) +TiO2 NPs (15 ppm) in second

experiment, and Cr(VI) +TiO2 NPs and Cr(VI) + gTiO2 NPs (15 ppm) in third experiment was exogenously sprayed on 20-days-old plants, thrice with a gap of 3 days to check for various parameters like Cr(VI)-accumulation, plants growth, photosynthesis, oxidative stress, AsA-GSH cycle, PCs content, and DNA damage. Results of first experiment revealed that Cr(VI) was accumulated in root and shoot, which significantly ($p \leq 0.05$) posed toxicity on morphological and growth parameters. Cr(VI) intensifies H2O2 and MDA production. Toxicity on photosynthesis is resulted due to inhibition in stomatal (A, E, GH2O) and non-stomatal. Results of second experiment showed that TiO2 NPs reduced Cr(VI) uptake in roots and shoots, up-regulation AsA-GSH cycle, which protects vital metabolic processes in plants like photosynthesis, DNA damage, and chelate HMs. The Cr(VI) effectively induces PCs biosynthesis in both root and leaf of *H. annuus* L. Importantly, TiO2 NPs positively regulated PCs synthesis under non-stress and negatively regulated under stress conditions. Results of third experiment showed mechanisms by which TiO2NPs and gTiO2NPs alleviated Cr(VI) accumulation in roots and shoots of *H. annuus* L., which result in loss of H2O2 and MDA content and lesser cellular DNA damage. TiO2NPs and gTiO2NPs up regulate AsA-GSH cycle. This study mainly confirmed that gTiO2NPs perform better than synthetic TiO2NPs at morphological, physiological and biochemical level to alleviate Cr(VI) induced toxicities on *H. annuus* L. It could be due to compatibility with biological system.

Contents

10. KAUSHAL (Siddhartha)
Spatio- Temporal Patterns of Forest Ecological Attributes and Habitat Distribution Modelling Of Prominent Species in The Indian Central Himalaya.
Supervisor: Dr. Ratul Baishya
Th 26558

Abstract

The fragile Himalayan mountain ecosystem is facing the most significant impact of climate change and negative anthropogenic activities. The Indian Central Himalaya (ICH) represented by the Uttarakhand state has the country's 7th largest share of very dense forest cover and 5th largest share of growing stock. Uttarakhands' 70% population inhabits the rural regions, and depends on forests for their sustenance. The research in ICH assessing the performance and threats to ecosystem attributes is limited to single forest type, climate zones, or study single process only. Considering this, the present study was undertaken in nine major forest types of the ICH covering an elevational span of 3100 meters to bridge the key knowledge gaps and provide necessary management implications. The results showed that the woody species of major ICH forest types have significant diversity comparable to global estimates. The woody species show not only clumped dispersion but also heterogeneous growing stock distribution in the forest types. There is biomass hyperdominance, and the soil inorganic carbon constitutes a significant share of the Himalayan acidic forest soil carbon stock. Soil nutrient content influences the biochemical properties of soil, which impact not only the decomposition of leaf litter but also plant physiological attributes viz.,

specific leaf mass and nutrient retranslocation efficiency. There is a spatial (elevational and distance from plants), temporal (seasons), and vegetational (diversity and density) influence on soil CO2 efflux. Poor regeneration of climax species has negatively modulated the density diameter curves to perilous decreasing and unimodal trends. Future climate modeling shows diminishing niche distribution for prominent species. Sustainable use of forest resources, stricter regulations, and the inclusion of local communities in forest management plans is key for an efficient conservation. Assisting natural regeneration and afforestation is crucial for ensuring the productivity and resilience of Himalayan forests.

Contents

1.General introduction and objectives of this research study 2. Description of the study area and general canopy characteristics 3. Composition and structure of the tree and shrub communities, tree species regeneration status and forest anthropogenic disturbance 4. Patterns of leaf nutrient retranslocation, litter dynamics and nutrient release 5. Assessment of soil physical, chemical and biochemical properties 6. Patterns and distribution of carbon stocks in forests and soil 7. Assessment of soil CO_2 efflux and its spatial, temporal and vegetation characteristics 8. Habitat distribution modelling of prominent Himalayan tree species- an ENM approach for conservation planning 9. Summary and conclusion. Literature cited. List of publications.

11. KRATI VIKRAM
Impact of Land Use on Soil Carbon and Nitrogen Content in the Kumaon Division of Central Himalaya, India.
Supervisor: Prof. K.S. Rao
Th 27005

Abstract

The study area of the Kumaon division of Central Himalaya is a characterized by temperate monsoon type of climate and comprised of different ecosystem diversity arisen due to forest fires, deforestation, degradation, population growth, declination by the cultivable area and soil erosion. The soil carbon and nitrogen storage across is studied land used systems is chiefly influenced by soil types, bulk density vegetation and land use management practices. The current study was conducted in the selected sites viz. The result of the study revealed that during 2017-2019 across the selected land use systems the soil organic carbon and total nitrogen stocks were in the order of peach orchard>kitchen garden>arable lands. The differences in the concentrations and stocks of SOC and TN across the studied systems could be attributed to differences in the type of soil, vegetation, management practices and diversification of cropping systems. Night peach trees on loam soil along with other management practices as addition of farmyard manure (FYM), tilling levelling. The contribution of KG and AL LUS in SOC and TN stock was found to be comparatively lesser than those of the PO suggestions that these sites could be the potential sites for C sequestration in the central Himalayan region.

Contents

1. Introduction 2.Review of literature 3. Study area 4. Soil organic carbon concentration, stock and mitigation potential 5. Soil total nitrogen concentrations stocks, distribution and C:N ration 6. Soil respiration 7. Soil nitrogen mineralization rates 8. Enzyme activities in soils. Summary and conclusions. References. Appendices. List of publications.

12. NOTUP (Tenzen)

Ecophysiology and Nutritional Potential of Staple Crops of Trans Himalaya Regions.

Supervisor: Prof. K.S. Rao

Th 26556

Abstract

Buckwheat (Fagopyrum sp.) and barley (Hordeum sp.) have attracted attention of food scientists due to their high nutritional value and increased demand. In trans-Himalayan region, where they are major grain crops, limited information on their cultivation, functional traits, and uses has been documented. The study aimed to determine the ecophysiology, functional traits, phytochemical composition, nutritional and antioxidant potential of these crops. Effect of elevation and manure addition in these areas were analysed on crop morphology, macro-, micro-elements and biomass of Fagopyrum tartaricum, F. esculentum, Hordeum vulgare and H. himalayens cultivated in the trans-Himalayan region along with a self-sustaining wild population of Fagopyrum sp. wild variety, commonly observed from this less traversed region of India. With elevation, biomass and element composition did vary in plant parts at both reproductive and vegetative stages. However, manure addition did not yield significant differences. Disparities in micro and macro elements, biomass and functional traits were also stark between vegetative and reproductive stages. When analysed for their nutritional composition, significant variation was observed in total carbohydrates, starch, and protein contents among these crops. Each species had a unique profile that can be accounted for its proper nutritional and economic use. Due to their cultivation in high altitudes, these crops face low temperature stress and are therefore observed to be enormously rich in their antioxidant potential. Phytochemical analysis indicated diverse functional compounds in grains of Fagopurum and Hordeum spp. All these factors reinstate these crops as an excellent supplement or replacement for better health choices. Immense indigenous knowledge on agriculture, livestock and use of forest products was also gathered during the study. Survey analysis on the agro-pastoralism lifestyle was also carried out. Preservation and documentation of such knowledge lays the basis for the conservation of traditional crops, knowledge and refined use of natural resources.

Contents

13. PARUL

Host Tree-Tropical Tasar Silkworm Interactions & Molecular Characterization of *Nosema* Species Infecting *Antheraea Mylitta* Drury And Other Non –Mulberry Silkmoths.

Supervisor: Prof. Sudeshna Mazumdar-Leighton

Th 26557

Abstract

This dissertation explores facets of Tasar sericulture practiced in central India by tribal communities which requires nutritious diets from diverse host trees and healthy eggs, free of Pébrine disease, for cocoon production in the next season.

Asynchrony in tree phenology coincident with Tasar silkworm rearing cycles; temporal variability in levels of foliar protein and protease inhibitors (PI) in different leaf types of two host tree species, Terminalia arjuna and Schleichera oleosa is reported, likely influencing production of PI-insensitive larval gut proteases as an adaptation to herbivory. Such studies on foliar nutrition can improve efforts to domesticate A. mylitta, benefitting rearers and conserve wild silkmoths. A major focus of this dissertation involved PCR-based detection, sequence-based characterization, and quantitation of Nosema species, which can cause Pébrine in A. mylitta populations from plantations and forests. Primers for rRNA operons, genes encoding tubulins, spore wall proteins, and polar tube proteins of Nosema isolates were successfully validated in A. mylitta, Antheraea assamensis and Samia ricini silkmoths. Their sequences are first reports. High intra-individual variation was evident in ITS and IGS regions. Nuclear genes of Nosema isolates from three non-mulberry silkworms were highly conserved, suggesting cross-transmissibility. Quantitative PCR indicated high disease incidence in the sampled mtCOI gene-typed, cultivated moths but not in wild antheriids, indicating urgent need for in situ conservation of populations in remote forests. Transmissibility of Nosema spores incorporated in diet of P. brassicae larvae showed limited infectivity. Differential gene expression of non-gut serine protease transcripts detected by qRT-PCR may be implicated in larval immune responses. Analysis of 5-year Tasar grainage data indicated yearly variation and influence of grainage location/site in Pébrine disease prevalence. Accordingly, the dissertation discusses feasability of large-scale, molecular screens for rapid, accurate, and sensitive detection of Nosema to supplement traditional microscopy-based screening of female moths for Pébrine.

Contents

14. PATEL (Kajal)
Ecological Performance of Woody Plants Exposed to Urban Pollution.
Supervisor: Prof. K.S. Rao
Th 27003

Abstract

The rise in urbanization has led to an increase in heavy metal pollution in the environment by contaminating its components i.e., air and soil and is a major cause of concern due to their persistent nature and health hazards. Both air and soil are among the most important components for survival and sustainability. The utilization of plants for the improvement of air and soil by dust interception, heavy metal accumulation, and tolerance is well reported.Therefore, the present investigations were carried out to screen the heavy metal accumulation potential, dust interception capacity (DIC), and air pollution tolerance indices of sixteen commonly growing woody plant species in the NCR of Delhi. The study was carried out in Delhi, as the continuous population growth and rise in transportation and city infrastructure are major players which make Delhi, one of the most polluted cities. From various analyses, we concluded that plant species such as *Ficus*

religiosa, Terminalia arjuna, Morus alba,Prosopis juliflora, and *Millettia pinnata* proved to be exceptional bio-monitors and bioaccumulators for heavy metals in urban areas. Moreover, *Terminalia arjuna, Ficus benghalensis,*and *Plumeria alba* were the best dust accumulators. And APTI (Air pollution tolerance index) was highest for *Ficus religiosa, Ficus benghalensis, Alstonia scholaris, Dalbergia sissoo,* and *Terminalia arjuna.* Such plant species with wide canopies and large and rough leaf surface areas with perforated veins are found to be suitable and recommended for the development of greenery to improve air quality in urban areas like Delhi. Therefore, these plant species are highly recommended for plantation in urban areas for decontamination of the air and soil by mitigating heavy metal pollution. Furthermore, seed germination and seedling growth are critical factors for the establishment of new individuals to develop a green microclimate in urban areas which got interrupted due to seed dormancy. Also, seed germination is very sensitive to ambient environmental conditions therefore, it can be used as an indicator of heavy metal pollution. A study was done to identify the best commonly growing plant species with high seed germination and seedling survival percentages under various pre-sowing treatments. For enhancement of seed germination, five treatments were undertaken including control (no treatment), cold water, hot water, acid treatment, and mechanical scarification. Consequently, the best-performing species under the best-suited treatments were selected. Further, the impact of Pb contamination in soil on the best species seedling stage was examined. We observed that hot water treatment and mechanical scarification were best followed by cold water, acid treatment, and control. And among the eight selected species.

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15. SATYA PRAKASH

Analysis of Gold Nanoparticle Protein Corona of Brassica Juncea to Understand Nano-Bio Interactions: A Step towards Sustainable Phytonanotechnology.

Supervisor: Prof. Renu Deswal

Th 27004

Abstract

Nanoparticles (NPs) adsorb proteins from their surroundings, forming NP-protein corona, which determines their fate, distribution, and effects, yet no information on plant protein corona (PC) was available tl late 2019. Here we report, the analysis of AuNP-protein coronas formed with Brassica juncea total leaf protein sample, leaf nuclear-enriched fraction, and seeding hypocotyl apoplastic fuid. Protein coronas were characterized by the techniques including SDS PAGE, spectrophotometry, dynamic ight scattering, zeta potential measurements, and Nano LC-MS/MS. Coated AuNPs had approx. 30% higher zeta potential than pristine AuNPs after 36 h of interactions with total leaf proteins or leaf nuclear enriched fraction. The increase in hydrodynamic radii and adsorbed protein concentrations were consistent with the evolution of zeta potential. Notably, 27% of hard corona proteins of the leaf total protein fraction were from energy-yielding pathways highlighting the potential abilty AuNPs to infuence the yield in Brassica juncea. We also compared chemically and green synthesized AuNPs for their

colloidal stability and interaction with Brassica juncea leaf proteins extract. Interestingly, Green synthesized AuNPs were more stable (zeta potential higher by 5-7 mV) owing to less protein adsorption and narrower size. The AuNP protein interaction with the RuBisCO showed a-helix to Bsheet transition by FTIR analysis. Finally, an attempt to isolate in vivo protein corona of seedling hypocotyl apoplastic fluid was made, however, the isolated complexes were not analysable due to very low concentration. Nevertheless, we studied in vitro synthesized apoplastic corona which showed reduced protein adsorption during the early phase (1-16h) and loss of optical property of AuNPs. We propose this as the protective mechanism used by the plant to avoid the aggregation of NPs inside the apoplast. This report is among the earliest reports of protein corona in plants and can serve as the basis for future studies

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16. TRIPATHI (Shreya)
Studies on the Community Ecology, Fuelwood Consumption Pattern, and Temporal Vegetational Changes in Orchha Wildlife Sanctuary, Madhya Pradesh.
Supervisor: Prof. Prem L. Uniyal
Th 27204

Abstract

The Orchha Wildlife Sanctuary in Madhya Pradesh`s Niwari district, located in the Bundelkhand region, lacks sufficient ecological research. This thesis investigates the gap through studying floristic inventory, phytosociology, fuelwood consumption pattern, and temporal changes in vegetation using Landsat data. Periodic floristic surveys were conducted within the sanctuary from 2019 to 2021, resulting in the compilation of a species checklist. Phytosociological assessments were conducted using the Quadrat method to examine the analytical and synthetic characteristics, regeneration, and forest structure of the sanctuary. Soil properties were evaluated using defined methodologies. A survey was conducted in 124 households across seven villages near the sanctuary to document fuelwood consumption pattern. Landsat data from 1981-2019 was used to analyze temporal variations in vegetation by classification using spectral indices. The floristic inventory recorded 120 plant species, with Fabaceae and Poaceae as the most common families. The soil exhibits low concentrations of organic carbon and macronutrients. The tree density and basal area of the Orchha forest were measured at 750 individuals ha-1 and 32 m2 ha-1, respectively. Tectona grandis was identified as the dominant species in the three layers of Trees, Saplings, and Seedlings, while Anogeissus pendula exhibited co-dominance. The forest displayed adept regeneration and a reverse J-shaped structure. The high values of expected annual mean collection, Probability of Use, and Resource Use Index for Tectona grandis and Anogeissus pendula suggest substantial collection pressure from villagers on these species. NDVI was determined as the optimal index for classification. The area was separated into six distinct classes and subsequent analysis indicated a significant decrease in the occurrence of Anogeissus pendula, while conversely, there was an observed increase in the area of Tectona grandis over a span of three decades. This documentation would aid in policy formulation, forest management, conservation, and comparative assessments with other Indian tropical deciduous forests.

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17. YADAV (Shobha)
Investigation into Evolutionary History, and Function of Segmentally Duplicated Paralogs *MYB42* and MYB85 in Promoter and Reverse Genetic Mutants.
Supervisor: Prof. Sandip Das
Th 26559

Abstract

The colonization of terrestrial ecosystem by plants approximately 450 million years ago marked a significant milestone in Earth`s history. Early land plants faced numerous challenges, including UV-B radiation and desiccation stress, which drove the evolution of phenylpropanoid metabolism pathway. The emergence of lignin deposition in their cell walls of tracheophytes, played a crucial role by providing structural support, water-conducting abilities, and acting as a defence barrier. Accumulation of lignin-rich biomass over millions of years eventually formed fossil fuels. Understanding the regulation of lignin biosynthesis therefore has broad implications, including bioenergy production, improved forage crops, development of renewable materials. Key genes of lignin biosynthesis include phenylpropanoid pathway genes such as C4H, CAD, POX which are in turn regulated by NAC and MYB transcription factors, and miRNAs. However, the precise functions of lignin-related genes in reproductive tissues and their positions within the lignin biosynthesis regulatory network remain poorly understood. Another lacuna is to understand molecular evolution of regulatory genes and elements modulating lignin biosynthesis in plants. Therefore, we addressed these knowledge gaps through four specific objectives (i) functional characterization of selected mutant lines in Arabidopsis which revealed role of NST1, NST2, and NST3 in plant growth; (ii) phylogenetic and comparative genomics analysis of MYB42 and MYB85 homologs across land plants revealed segmental duplication as cause of paralogy, and history of origin MYB42/MYB85; (iii) in-silico and functional analysis of promoters unravelled transcriptional regulation of MYB42 and MYB85 in secondary cells with lignin; and, (iv) functional characterization of MYB42 and MYB85 in Arabidopsis indicating their role as negative regulator of lignin biosynthesis. By achieving these objectives, we hope to shed light on the specific roles of MYB transcription factors in overall plant development, particularly in secondary cell wall formation, and contribute to a more comprehensive understanding of lignin biosynthesis regulation.

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