C. reticulata, C. limonia and C. medica were taken for AMF isolation. Depending on their abundance two AMF spores were selected, i.e. Glomus fasciculatum and Gi. gigantea were taken up for all the in vivo studies. Spores isolated were mass multiplied in maize, sorghum and turf grass.

Scanning electron microscopic observation was made for the AMF spores. Differences in their wall characters and ornamentations were observed.

Screening for resistance of mandarin against F. solani and F. oxysporum was undertaken. Seedlings from Mirik and Kalimpong Block II were found to be highly susceptible to the pathogen.

Three important PGPF viz. one isolate of T. asperellum and two isolates of T. harzianum were isolated from the rhizosphere of mandarin. T. asperellum (RHS/M/511) and one isolate of T. harzianum (RHS/M/511) showed better in vitro antagonistic activity as a result they were taken up for further studies.

Among all the bacterial isolates RMK03 showed positive for most of the PGPR tests.

Strong precipitin reactions occurred in homologous reactions in immunodiffusion test of F. solani and F. oxysporum. Western blot analyses using polyclonal antibody of F. solani and F. oxysporum revealed that the PAb could show different levels of homologous reactions with the antigens of F. solani and F. oxysporum respectively. Sharp and intense bands were produced on the nitrocellulose membrane after enzymatic reaction with NBT-BCIP. Efficacy of polyclonal antibodies raised against the mycelial proteins used as antigen source was further tested with the help of indirect immuno fluorescence of young mycelia of F. solani and F. oxysporum. The mycelia treated with PAbs and labeled with FITC showed apple green fluorescence.

RAPD-PCR and Phylogenetic analysis of Fusarium and Trichoderma isolates was carried out. The genetic relatedness among isolates of Fusarium and Trichoderma were analyzed separately by random primers to generate reproducible polymorphisms. All amplified products with the primers had shown polymorphic and distinguishable banding patterns which indicated the genetic diversity of all isolates.
The fungal and bacterial isolates designated as potential PGPF and PGPR were confirmed with the help of 16S rDNA sequences. The BLAST query of the 16S rDNA sequence of the isolates against GenBank database confirmed the identity of the isolate RHS/M/511 as *T. harzianum*, RHS/M 512 as *T. asperellum* and RMK03 as *Pseudomonas poae*. The sequences have been deposited in NCBI, GenBank database under the accession no. GQ995194 for *T. harzianum*, HQ265418 for *T. asperellum* and KJ917553 for *P. poae*.

The BLAST query of the 16S rDNA sequence of the isolates against GenBank database confirmed the identity of the isolate RHS/M534 as *F. oxysporum* and RHS/M532 as *F. solani*. The sequences have been deposited in NCBI, GenBank database under the accession no. KF952602 for *F. oxysporum* and KF952603 for *F. solani*.

A multiple sequence alignment of ITS gene sequences of the above sequenced isolates was also conducted. Phylogenetic analysis of the isolates was carried out with the Ex-type strain sequences obtained from NCBI Genbank Database which showed maximum homology with their respective isolates.

Abiotic stress was observed in mandarin plants in drought and flood condition. Enhanced changes in antioxidative enzymes such as peroxidase, catalase and ascorbate peroxidase was observed. Carotenoid showed a significant decrease during flood stress but increased in drought stress.

Activation of defense responses in mandarin after inoculation of AMF and PGPF resulted in growth of plants along with increase in number of branches and leaves. Enhanced increase of defense enzymes after pathogen inoculation was observed especially after joint inoculation of AMF with PGPF respectively. Dual application of *Gi. gigantea* and *T. asperellum* induced additional isozyme in native PAGE. Induction of flower and fruit was also enhanced on application of the bioinoculants, *Trichoderma* and AMF.

*P. poae* isolated from mandarin rhizosphere proved to be a potential PGPR on screening with other PGPR isolated from horticultural and plantation crops. Activation of defense responses in mandarin after inoculation of *Gi. gigantea* with *P. poae* resulted in growth of plants along with increase in number of branches and leaves. Enhanced increase of defense enzymes after pathogen inoculation was observed especially after joint inoculation. Immunological tests also confirmed the efficacy of joint inoculation of *Gi. gigantea* with *P. poae*
One bacteria (MHB) was successfully isolated from *Gi. gigantea* spore originally obtained from mandarin root rhizosphere. The bacteria isolated was rod shaped and gram positive. The identity of the isolate was confirmed with the help of 16S rDNA sequences. The BLAST query of the 16S rDNA sequence of the isolates against GenBank database confirmed the identity of the isolate MHB as *B. mycoides*. The sequences have been deposited in NCBI, GenBank database under the accession no. KJ917554.

Strong apple green fluorescence was observed in case of FITC and bright red in case of RITC in spores of AMF. The fluorescence was distributed throughout the spore wall. Fluorescence was more intense in wall layer of young spores.

Strong apple green fluorescence was observed in the epidermal and mesophyll tissues in leaves and homogenously in cortical cells and epidermal cells in roots. Enhancement of chitinase was revealed in both leaves and roots following induction.

The systematic response of induced resistance in mandarin plants using PAb of chitinase following successful colonization with AMF as well as treated with *T. asperellum* was observed through Transmission Electron Microscopy. Heavy deposition of gold particles was observed near the cell wall of inoculated roots.