Summary & Conclusions

Summary

One of the important approaches to alleviate salinity stress in plants is to inoculate with specialised bacterial strains that can promote plant growth under high salt. The present work dealt with understanding the effect of salt on the bacterial phenotypic traits that are associated with plant growth promotion. Further studies were done to know how consortia behaved under salt stress as compared to individual strains. This was then followed by plant inoculation experiments for assessment of the effectiveness of the consortia in promoting plant growth. The following is a summary of the studies undertaken and the outcome in brief.

- Ten bacterial strains were selected for the present study, which included *Enterobacter* sp. EC1D, 2 standard strains *Pseudomonas fluorescence* PCHA0 and *Pseudomonas protegens* Pf-5, 4 isolates PG16, PG19, PG22 and PG38, *Rhizobium* spp. RST1, RIC3109 and *Sinorhizobium fredii* NGR234.
- Salt tolerance among the bacterial strains was highest in EC1D, followed by *Pseudomonas* spp., *Rhizobium* spp. and least in NGR234.
- The salt stress enhanced biofilm production in the most of PGPR strains. Phosphate solubilization under salt stress was observed only in EC1D, Pf-5, PG22 and PG38.
- IAA production under salt stress was enhanced in the *Rhizobium* spp. while EC1D also showed high IAA production in stress.
- Ammonia production was moderately present among all the strains up till 2% salinity.
- The pseudomonads showed an increase in the antifungal metabolite production under salt stress (Pf-5, PG19, PG22), HCN production was observed till 3% salinity (PCHA0, Pf-5, PG22, PG38).
- When in consortium, P-solubilization efficiency was enhanced up to 5% salt stress, siderophore production till 3% salinity, IAA produced among consortia was low which enhanced at 3% and 4% salinity, biofilm production was enhanced in most of the consortia at high salt stress, ammonia production was moderate while HCN production was absent.
- Formation of consortia led to stability in trait exhibition and salt tolerance for most of the PGPR traits. The exhibition of PGPR traits under salt stress was dependent on the pseudomonad strain present in the consortium.

- The consortia having **EC1D**, pseudomonads **PG38**, followed by **PG22** and **Pf-5** showed highest tolerance towards salt stress for PGPR trait exhibition. Among the rhizobia, **RST1** showed maximum PGPR activity under salt stress.
- Genus specific primers were designed for selective amplification and relative growth estimation of the bacterial strains in consortia.
- The PGPR consortia under salt stress enhanced P-solubilization up to ~2-folds
- Semi-quantitative PCR showed the consortia **C2S** having maximum population density of all strains which corelated to the high P-solubilization efficiency displaying synergy.
- The PGPR were grown under salt stress and the bacterial density was established using the q-PCR technique.
- In consortia, maximum increase in bacterial population was observed in EC1D and NGR234, while pseudomonads and the rhizobia had enhanced tolerance towards high salt concentrations.
- The *Cajanus cajan* plants were found to be highly salt sensitive and did not survive at 0.3% salt concentration in soil.
- Plants treated with individual PGPR strains and their consortia were able to grow at 0.3% salinity.
- The strains PG22, RST1 and consortia C2S, C2I showed maximum effect of salt stress alleviation in the plant growth parameters.
- Under biotic stress in the form of *Fusarium udum* infection, PG22 along with consortia C3I, C1N showed the maximum stress alleviation of biotic stress on pigeon pea plants.

Conclusions

Consortia of PGPR showed improved sustenance under high salinity in terms of growth and exhibition of plant growth promoting traits as compared to individual strains. Effectiveness of the consortium varied with the members of the consortia indicating strain specific interactions might result in differential populations and behaviour. The impact of population density led to the dominance in phenotype expression and consortial synergy enhanced the microbial sustenance. The consortium C2S (comprising EC1D, PG22 and RST1) was most suitable for alleviation of salt stress and C3I (EC1D, PG38 and RIC3109) showed maximum alleviation

of biotic stress in plants, while C2I (EC1D, PG22, RIC3109) demonstrated optimal performance against both the stresses.

This work could form a baseline for understanding *rhizospheric interactions* under stressed conditions using simple *molecular techniques*. Furthermore, this work has great potential for use in field applications in the rapidly changing climatic conditions.