

**“Development and evaluation of *Pseudomonas* based
bioformulation for disease control and growth
enhancement of *Zea mays* L.”**

Thesis
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Babasaheb Bhimrao Ambedkar University
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8. SUMMARY

Cereal crops have always been the main source of calorie in our diet. Cereals like wheat, rice and maize are the most important food commodities. In India, maize is the third most important food crop after rice and wheat and contributes a lot in daily protein requirement. In last few years production of maize has substantially increased at global level but this rise in production also emphasized overuse of mineral fertilizers in maize fields. Similarly, it has been also observed that measures applied in maize disease control are inefficient and involved harsh chemicals/pesticides. Rot diseases of maize have global significance and amongst them ear and charcoal rot are considered most destructive. In India, estimated losses due to major diseases of maize is about 13.2% of which 5 % is caused by rot diseases which results in heavy yield loss. As already mentioned, in absence of effective measures of maize disease eradication every year a percent of yield loss is increasing. Hence there is an urgent need to formulate biological approaches to treat maize diseases and enhance productivity in sustainable manner. Rhizospheric microbes have are known as suitable candidates for enhancing plant growth. Amongst the rhizospheric microbes, fluorescent pseudomonads are considered as dynamic PGPR, influencing plant health by several activities.

In the present study 42 fluorescent pseudomonads were isolated from diverse crops grown in Lucknow and nearby regions. Further isolates were characterized on the basis of morphological and biochemical characteristics which showed isolates, resemblance with fluorescent pseudomonads. All the isolates were also monitored for their PGP and biocontrol activities against ear and charcoal rot fungi (*F. moniliforme* and *M. phaseolina*). On the basis of various PGP traits and biocontrol potential against rot fungi, the isolate PFJM1 was found to be most efficient among all and hence was further characterized by 16S rRNA gene

sequencing. 16S rRNA genes of isolate PFJM1 (accession number: KT734728) shared maximum (99%) similarity with fluorescent *Pseudomonas* group (taxid:136843).

A comprehensive study of all the isolates for monitoring their PGP and biocontrol activities were also conducted. The study confirmed that maximum isolates were able to solubilize P, Zn and produce phytohormones (IAA and Gas). Apart from this, siderophore, HCN production and biocontrol activity against *M. phaseolina* and *F. moniliforme* was found to be present in some isolates. Amongst all, PFJM1 displayed maximum PGP traits and also showed biocontrol potential against rot fungi and was selected for further study.

Role of PFJM1 in suppression of rot fungi i.e. *M. phaseolina* and *F. moniliforme*. was also observed under SEM. In SEM bending of mycelium, fragmentation, absence of sclerotia formation and conidial deformities were observed. Isolate PFJM1 was found to produce HCN and different types of siderophores that can contribute to inhibition of pathogenic fungi. The initial separation of crude metabolite of the strain *P. fluorescens* JM-1 by using TLC revealed two major spots with Rf values of 0.74 and 0.78. Of which one spot (Rf 0.78) showed antifungal activity against both the fungi as evident in bioassay. Partial characterization by UV-Visible and FT-IR spectrophotometry showed the similarity of this compound with 2,4-DAPG. UV-Visible spectrum demonstrated a nearly identical λ max (270 nm) whereas FTIR spectrum showed (cm⁻¹) 3400-3200 (OH Br) 1600-1400 (aromatic conjugated C=O with intramolecular hydrogen bonds and aromatic C=C), 1200–1000 (COH), similar to synthetic DAPG.

Hence isolate PFJM1 showed production of various metabolites including DAPG. considered as multi-trait PGP and DAPG producer. Effect of PFJM1 on maize growth enhancement and rot diseases suppression were also monitored in pot and field experiments. In pot experiment seed treated with PFJM1 showed reduced ear and charcoal rot disease (by 68 and 74% respectively) in comparison to pathogen control. Apart from disease their was

enhancement in reduction maize growth parameters. Results of pot experiment clearly indicated usefulness of PFJM1 as potential bioinoculant for maize growth enhancement and disease suppression of rot fungi.

To prove efficacy of PFJM1 in treating rot diseases and growth enhancement in field conditions, a talc based bioformulation was also prepared. The survival of PFJM1 was checked in bioformulation till six months of storage and it was found that its population density was maintained above 1×10^8 CFU g^{-1} . The bioformulation was applied in two different fields, where incidence and prevalence of rot diseases were already reported. The soil of BBA University is alkaline and nutrient poor and reported to be infested with *M. phaseolina*. Here application of PFJM1 bioformulation reduced disease incidence. However, soil of the Itaunja village field (Sitapur, UP, Lucknow) which was slightly alkaline and fertile showed 78% reduction in disease incidence (of *F. moniliforme*) when treated with PFJM1 bioformulation. At Itaunja prevalence of ear rot of maize is reported by local farmers and synthetic fungicide Thiram is being used by local farmers to treat the seed-borne fungal diseases of maize. However, result of both fields studies indicated that use of PFJM1 was found very effective in controlling ear rot and charcoal rot incidence in comparison to untreated and Thiram treated seeds. Apart from this, seed coated with PFJM1 were also found to enhance maize growth parameters over control. Yield in terms of ear fresh weight, ear dry weight, number of seed per plant and 100 grain weight was also found to increase sign of deficiency 90 DAS (over control) in both the fields.

In brief, from present study it can be stated that use of multi-trait PGP and biocontrol metabolites producing *P. fluorescens* not only enhanced maize growth but also effectively suppressed rot diseases in maize caused by soil borne fungi. The study also reports development of effective talc based bioformulation from DAPG producing *P. fluorescens* JM-1 development. The issues related to maize yield in terms of quantity and quality can be

resolved by application of such multi-trait strain leading to food security in a sustainable manner.

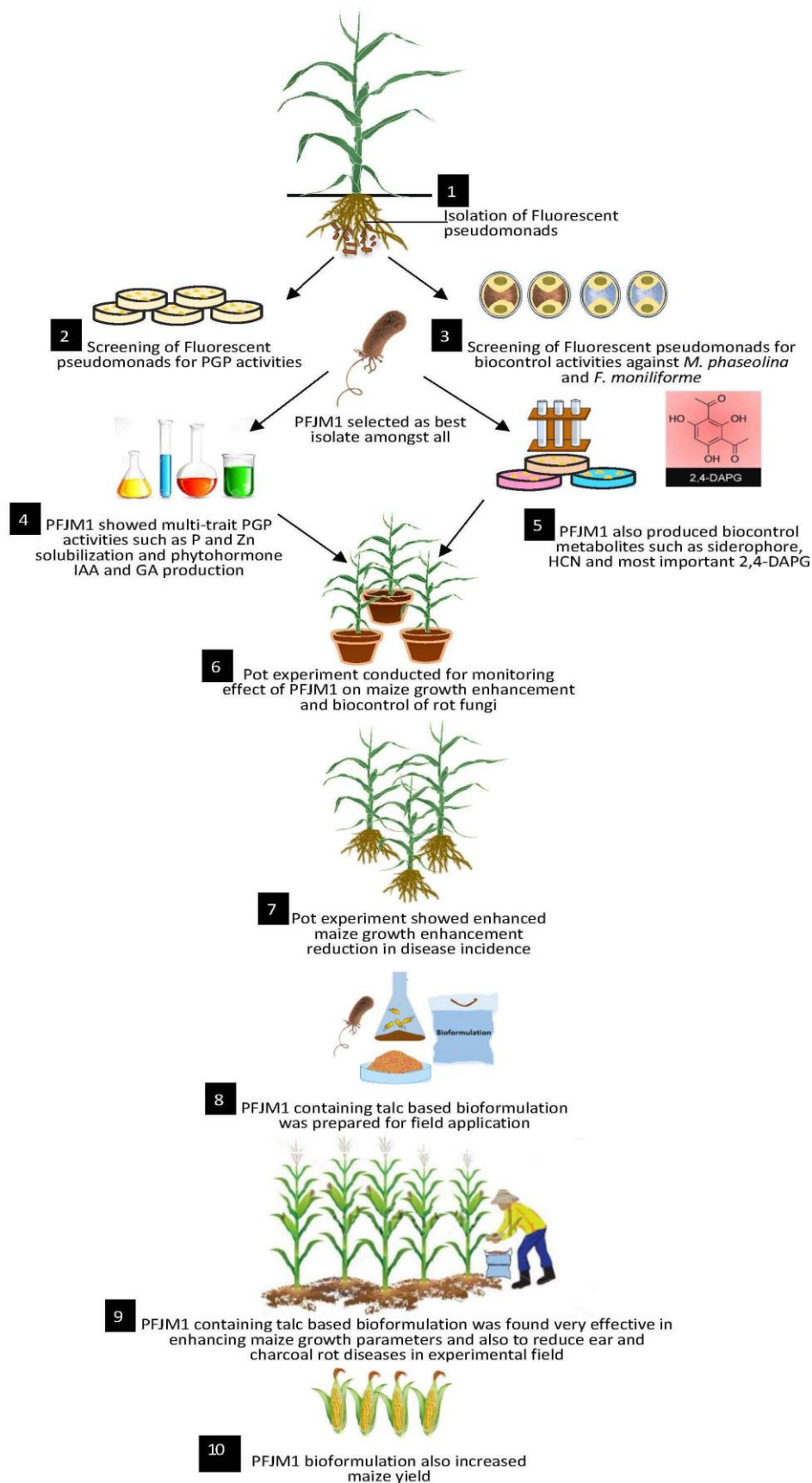


Figure 51. Summary of the work done