Diazotrophic Biofertilisers for Hill Agriculture

Nitrogen is one of the primary plant nutrients that plays a major role in achieving the maximum economic yields; however, is limited to mountain agro-ecosystems. This leads to the intensive use of synthetic chemical fertilizers. Overdose of these chemicals is detrimental to the environment in the long run. Most commercial fertilizers contain plant-available N in one of two inorganic forms: ammonium (NH_{4+}) or nitrate (NO_{3-}). Another form of N that is synthesized by fertilizer manufacturers and is commonly used by farmers is urea. After application to the soil, urea undergoes chemical changes and liberates ammonium (NH_{4+}) ions. Soil moisture determines how rapidly this conversion takes place. Synthetic N fertilizers containing ammonium, nitrate, or urea are considered to be "quick-release" fertilizers that can rapidly being available to plants. When a urea particle dissolves, the area around it becomes a zone of high pH and ammonia rich. This zone can be quite toxic for couple of hours. Seed and seedling roots within this zone can be killed by the free released ammonia.

Biological nitrogen fixation (BNF) is a process carried out by special group of bacteria, collectively known as diazotrophs. These microorganisms convert the atmospheric nitrogen (N_2) to ammonia (NH_3). Unlike the chemical process to synthesize fertilisers, this process does not require external energy inputs as the bacteria are capable to meet their energy demands via organic compounds in soil. Moreover, the soil health is also enhanced for the subsequent crops. Thus, in order to achieve sustainable agro-ecological systems diazotrophs can be a better alternative for conventional agricultural practices.

Bacterium *Rhodococcus qingshengii S10107* was isolated from an agriculture field of Munsyari, situated at Kumaon region of Western Indian Himalaya. This bacterium showed nitrogen fixing ability, as observed by growth in a nitrogen-deficient medium (Burk's medium) under laboratory conditions. Further, PCR amplification studies confirmed the strain to be *nif*H positive.

In the field trial experiment, strain S10107 not only showed better plant growth promontory activity in *Cicer arietrinum* but also improved the soil fertility status. Thus this bacterial strain could be used as potent diazotroph for agro-ecological systems.

Advantages:

1. The potential diazotroph, *Rhodococcus qingshengii* S10107, is superior than chemical fertilisers
2. Chickpea (*Cicer arietinum*), is an important leguminous rabi crop of India The strain S10107 helps in combating soil acidification problem by maintaining the pH to neutral.
3. The use of this strain reduces cost and labour inputs as there is no need of frequent application due to its persistence in field upto 75 days after sowing.
4. S10107 strain retains its nitrogen fixing ability even after long term storage.
5. The large scale production of S10107 can be carried out by using simple culture medium based techniques.
6. A variety of application methods can be used such as seedling root dip, seed treatment, and soil treatment. These can be applied in various forms such as carrier based (powder based), granular form and liquid formulation.
7. Once revived, this bacteria can be maintained by repetitive sub-culturing and storage at low temperature (-80°C) for a long period of time.
8. S10107 is identified as non-pathogenic in nature. Thus, no risk of any disease outbreak in plants and animals.
9. S10107 improves soil fertility status and reduce dependency on chemical fertilizers by restoring soil natural microflora.S10107 has temperature optima of 15 °C, therefore, is suitable for hill agricultural system also.