Additionally, Methylobacterium has potential applications in agriculture for increasing soil health, crop health and productivity, mitigate biotic and abiotic stresses. Methylotrophic communities help in proliferation of plant directly by improving nutrient and water use efficiency, nitrogen fixation, solubilization of phosphorus, potassium and zinc, production of phytohormones viz., cytokinins and auxins; production of Fe-chelating compound and ACC-deaminase activities or indirectly through production of ammonia, siderophores and secondary metabolites. The abiotic stress tolerance ability of different methylotrophs and their colonization in different parts of plants under severe low and high temperature, drought and salt stress condition is well documented. On the plant surface, methylotrophs exude osmo-protectants such as sugars and alcohols which ultimately help to protect the plants from desiccation and excessive radiations. This organism also plays a considerable role against pest, disease and nematode damage. Encompassing their use as biostimulant, biofertilizer, and biocontrol agent, Methylobacterium may facilitate sustainable crop production under global climate change.

Application of Methylotrophs

Method of application

Foliar spray (1% concentration – 10ml in 1000ml water)

Time of application

At critical stage of crop growth - 10 days after transplanting, active tillering stage, panicle initiation and flowering stage

Additional benefits

1. Helps to reduce plant stress in adverse conditions.
2. Improves nutrient use efficiency and water use efficiency.
3. Increase yield by 10-15 %
4. Reduce the usage of pesticides and fungicides, growth hormones
5. Enhances plant growth, seed vigour and germination, systemic resistance
6. Improves quality of the produce.

Further Information

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TNAU-IFPRI Collaborative Research Project on

Methane Reduction in Rice Farming Systems in Tamil Nadu

Methylobacterium and Methane Mitigation in Rice

Centre for Agricultural and Rural Development Studies (CARDS)
Tamil Nadu Agricultural University, Coimbatore
&
International Food Policy Research Institute (IFPRI)
Washington DC, USA
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Methane Mitigation by Methylobacterium in Rice Ecosystem

Methane (CH_4) is a potent greenhouse gas, short-lived climate pollutant (SLCP) and the second largest contributor to global warming (40%) after CO_2. Globally, over 60% of methane emission comes from industrial gas and petroleum systems, livestock and rice cultivation. Of these, rice cultivation contributes to around 9% of methane emission. In rice fields, methane is produced due to the anoxic environment created by flooding, which favors the growth of methanogenic bacteria, and decay of organic matter derived from root exudates. The rice plants themselves plays a major role in funneling emission from the soil to the atmosphere through the roots and transported upwards through aerenchyma tissue. The concentration of methane in the medullar cavity of rice plant was around 2900 times than the ambient air. For 1 kg of rice grain production, rice field contributes 100g of CH_4 to the atmosphere. The default methane baseline emission factor is 1.3 kg CH_4 ha^{-1} day^{-1}, in flooded rice system.

It is utmost importance for agriculture to address methane mitigation by optimizing field management practices, changing fertilization methods, and changing crop planting structures. For irrigated rice cultivation, methane emissions may be reduced by using efficient water management techniques such as direct dry seeding, intermittent irrigation, mid-season drainage, system of rice intensification (SRI) (29%), alternate wetting and drying (AWD) (44%) and aerobic rice cultivation (51%).

Although above-water management strategies show reduced methane emissions, consumption of less water for initial field setup and surface mode flood irrigation during an entire rice-growing cycle reduces the water productivity of the rice crop. As we move into the future, rice production must increase to feed an increasing population, while at the same time, methane emissions from irrigated rice need to be reduced to stabilize the global climate. Thus, the relationship between water requirement, rice yield and methane emission from rice fields emerge as a major scientific and policy issue. To address this issues, Methylotrophs – bioinoculant based strategies offer an exciting technology that can significantly reduce the methane gas emission through oxidation and also increase the yield and mitigate abiotic stress in plants through cytokinin synthesis when used as foliar biofertilizer. Application of Methylotrophs can be integrated with the currently existing or developing technology for methane mitigation.

Pink pigmented Facultative Methylotroph (PPFM)

Methylotrophs can utilize compounds such as methanol, methylamine, dimethylamine, formate, formaldehyde, methane, as a sole source of carbon and energy and also on a wide range of multi-carbon substrates and is a frequent participant in the global carbon cycle. The biological oxidation of CH_4 by Methylotrophs accounts for ~5% of the global sink of atmospheric CH_4 and oxidizes upto 90% of the CH_4 produced in the soil before it escapes to the atmosphere.

Methylobacterium also known as "Pink Pigmented Facultative Methylotrophs" (PPFMs), are ubiquitous in nature, aerobic and utilize C_1 compounds by oxidizing them to yield formaldehyde, which in turn can either be used for energy or assimilated into cell biomass. Methane is oxidized to methanol by methane monooxygenase enzyme. The methanol is then oxidized to formaldehyde by methanol dehydrogenase, and the electrons from this oxidation are donated to an electron transport chain for ATP synthesis. Formaldehyde can be assimilated into cell material by the activity of either of two pathways, one involving the formation of the amino acid serine (serine pathway in Type II organisms) and the other proceeding through the synthesis of sugars such as fructose 6- phosphate and ribulose 5-phosphate (RuMP pathway in type I organisms). This initiative represents a big step forward in tackling the methane emissions in the crucial rice sector. Application of Methylobacterium, as foliar application, soil inoculation or through seed treatments can outcompete or inhibit methanogenic microbes by consuming available substrates.