**Influence of environmental factor on symbiotic N₂ fixation:**

Environmental factor May affect N₂ fixation by:

1. Reducing rhizobium survival in soil.
2. Influencing growth of the host plant.
3. Failure of Nodulation.

Critical factors which influence symbiotic N₂ fixation include acidity, temperature, mineral nutrition, salinity, and alkalinity.

**Acidity:**

An acid soil N₂ fixation is reduced due to discreet effect of H+ ions concentration presence of toxic level of aluminum and Manganese deficiency of Ca, P, and molybdenum. Soil acidity limit rhizobial growth and persistence in soil. Sinorhizobium meliloti strain of bacteria is acid sensitive. Failure of nodulation is also common in acid soils due to lowered survival of rhizobia and rhizobium attachment to root hair.

**Approaches to overcome the problem of acidity:**

* The use of acid tolerant inoculant strains.
* The use of acid tolerant host cultivators.
* The plating of (coating) of inoculated seed with the layer of ground rock phosphate or limestone.

In Australia the use of acid tolerant S meliloti strain together with acid. Tolerant medicago variety resulted in extension of the area sown to this crop.

Tolerance of plant species to aluminum and manganese toxicities is less as compared to bacteria.

**Temperature:**

1. Most of the rhizobia cannot grow below 10°C or above 37°C. There are few exceptions for example rhizobia associated with legumes and Brady rhizobia isolated from hot, dry climate of Africa can tolerate temperature higher than 37°C.
2. Exposure to high temperature during shipment storage of inoculant and seed inoculation may cause loss of symbiotic plasmid in rhizobium.
3. High temperature can also reduce cell numbers below levels need for good nodulation.
4. Temperature can also influence nodule growth, functioning and the time period for which nodules are active. The optimum temperature for most of the legumes is 25°C.A Temperature greater than 40°C even for a short period of time can cause Irreversible loss of nodule function.

**Mineral Nutrition:**

Generally plants supplied with all essential nutrients nodulate and fix N₂ better than those that are nutrient deficient. Nutrient elements like Phosphorus, molybdenum and iron perform specific functions in nodulation and symbiotic N₂ fixation. Adequate supply of these element is essential for effective symbiotic N₂ fixation.

**Specific functions of these elements are given below:**

**Phosphorus:** Leguminous plants dependent on N₂ fixation require more P as compared to plants applied with fertilizer nitrogen. Nodules are an important sink for phosphorus. High energy cost of symbiotic N₂ fixation needs large amount of ATP and hence phosphorus. Bacterial strains and host cultivars differ in their Phosphorus use efficiencies.

**Molybdenum:** The principal function of molybdenum in the legume rhizobium Symbiosis is as the component of nitrogenase enzyme complex. The application of 100 to 500 g per hectare molybdenum can fulfill the needs of this element.

In acid soil the absorption of molybdenum reduces the availability of this element to plants. The addition of aluminum with the inoculant is not recommended as it can reduce the survival of rhizobia in the inoculant.

**Iron:** Iron is a component of leghaemoglobin which functions in the regulation of oxygen supply to bacteria. It is also component of both the Fe and Fe Mo proteins of the nitrogenase complex. It is essential for early nodule development. Plants which are iron deficiency develop few functional nodules. Bacteria and legume plants differ in iron utilization efficiency. Some strains of bacteria can produce iron sequestering siderophores (high affinity iron chilating compounds) so compete more efficiently for iron in the rhizosphere.

**Salinity and alkalinity:** The effect of salinity and alkalinity is greater on the host or Symbiosis then rhizobia.

Alkaline soil conditions limit the availability of iron, zinc, magnesium, and Boron in the soil, thereby reducing plant growth and N₂ fixation.

Foliar application of micronutrients is often an effective remedy. Legume are more sensitive to Salt then rhizobia. Cells of rhizobium exposed to high salt concentration often accumulate osmo regulants such as glutamic acid, glycine betaine and psoline which help to maintain turgor in the cell and limit damage caused by salts.