TWINN

Mechanism of Action of TwinN in Crop Plants

BACKGROUND

TwinN is a freeze dried microbial product for use in improving crop productivity. The microbes are *Diazotrophs* whose modes of action in improving plant productivity have been comprehensively described in the literature over many years. TwinN has been successfully used in broad acre crops including wheat, corn, barley, oats, sorghum, rice, cotton, soybean, lupins, mung beans, pastures and many others. It has also been used in many horticultural and tree crops including bananas, cauliflower, tomato, lettuces, celery, spinach, potatoes, grapes, apples, avocado, palms, macadamia and citrus. The microbes are applied to the foliage or the root system in water. After application they multiply to exist within the plant leaves, stems and roots as endophytes and also colonise the rhizosphere (the soil zone in close proximity to the roots and root hairs). TwinN is used in combination with reduced rates of chemical nitrogen fertiliser in conventional production systems, or applied with organic sources of nitrogen in organic cropping systems.

PRIMARY EFFECT

TwinN microbes act to fix atmospheric nitrogen into nitrogenous compounds that are immediately available to the plants. The nitrogen is fixed within the tissues by the endophytes and is also released by the TwinN microbes living in the rhizosphere where it is efficiently captured by the plant roots. The ability of TwinN microbes to fix nitrogen for both leguminous and non-leguminous crops enables a reduction in the application of chemical nitrogen sources such as urea.

Diazotrophs, including TwinN microbes, have an enzyme called nitrogenase which is used to fix nitrogen for the plant's use via the conversion of nitrogen (N_2) from the atmosphere to ammonia (NH_3) which is available for use by the plant. The reaction consists of:

$$N_2 + 8\,H^+ + 6e^- \;.\; 2NH_3 + H_2$$

The result is the fixation of nitrogen from the atmosphere into the crop plants in a manner very similar to fixation of nitrogen by *Rhizobium* in legumes.

SECONDARY EFFECTS

Root Growth

Diazotrophs such as those provided by TwinN have been shown to produce a range of Plant Growth Factors (PGFs), some of which mimic plant hormones such as auxins. These induce increased plant growth, particularly root growth and root hair density. The resultant root system acts to capture nutrients more effectively. Application of urea and other chemical nitrogen fertilisers can result in significant leaching of the fertilisers, as they are poorly bound by soil particles. This results in environmental problems as the nitrogenous compounds enter waterways and aquifers. It also results in decreased economic efficiency as expensive fertilisers are washed out of the root zone. The improved capture of nitrogen that would otherwise be lost to leaching is part of the reason TwinN allows maintenance of high yields with reduced inputs of chemical nitrogen fertilisers.

Mapleton Agri Biotec Pty Ltd
137 Obi Obi Road,
Mapleton Qld 4560 Australia
Phone: +61 7 5445 7151
Email: TwinN@mabiotec.com www.mabiotec.com

Mapleton Agri Biotec Pty Ltd

nitrogen fertilisers can result in significant leaching of the fertilisers, as they are poorly bound by soil particles. This results in environmental problems as the nitrogenous compounds enter waterways and aquifers. It also results in decreased economic efficiency as expensive fertilisers are washed out of the root zone. The improved capture of nitrogen that would otherwise be lost to leaching is part of the reason TwinN allows maintenance of high yields with reduced inputs of chemical nitrogen fertilisers.

Nutrient Availability

Diazotrophs, such as the TwinN microbes existing in the rhizosphere, have been shown to release a range of substances that solubilise nutrients such as phosphorous and some micronutrients that, in many soils, are bound so tightly that they are unavailable to crops. Application of TwinN acts to make some of these available to the plant roots for uptake. This is via the production of organic acids such as gluconic acid, oxalic acid, citric acid, lactic acid, tartaric acid, and aspartic acid. These drive the following soil reactions to release bound phosphorous from substrates such as dicalcium phosphate and hydroxyapatite into a soluble form for use by the crop plant:

$$\text{(Dicalcium phosphate) } CaHPO_4 + H^+ \longleftrightarrow H_2PO_4 + Ca^{2+}$$

$$\text{(Hydroxyapatite) } Ca_5(PO_4)_3(OH) + 4H^+ \longleftrightarrow 3HPO_4^{2-} + 5Ca^{2+} + H_2O$$

These reactions are two of a number of reactions by which bound nutrients are made available for uptake by the action of microbial exudates. Other elements whose availability is increased by the action of microbial exudates are iron and manganese.

Soil Health

TwinN helps to improve soil health in several ways. As a general rule, the ability to grow crops with less nitrogen fertiliser will improve the soil since nitrogen fertilisers will acidify soils over time and an excess of nitrogen fertilisers tends to reduce valuable soil carbon. Use of TwinN and a lower rate of nitrogen fertiliser will improve soil quality over time.

Soil micro-organisms are a key part of soil health. They contribute to nutrient cycling and a balanced microflora will assist in reducing disease pressure from soil pathogens. Some agrochemicals and fertilisers have very bad effects on beneficial microbes, and soil-borne diseases can be the result. Studies by scientists at the USDA in Illinois of the effects of TwinN on soil microflora around roots of soybean and maize found that TwinN increased beneficial microbes associated with micronutrient availability and suppression of soil pathogens. This led to a measurable decrease in Fusarium infection of roots. In soybean trials, nodulation was also increased in TwinN treated plots.

Application of TwinN can help in restoring the balance of soil microflora in soils that have been exposed to intensive farming practices and this can assist in reducing disease pressure from soil pathogens (although TwinN is not a disease control product).

CONCLUSION

TwinN is a technology that enables mainstream crop producers to conveniently use 'biological approaches' that were previously incompatible with their cropping systems. The technology enables higher profitability while improving the soil on which crop productivity relies.

Mapleton Agri Biotec Pty Ltd
137 Obi Obi Road,
Mapleton Qld 4560 Australia
Phone: +61 7 5445 7151
Email: TwinN@mabiotec.com www.mabiotec.com

Mapleton Agri Biotec Pty Ltd