Innovative “Slow Release” Liquid-Nitrogen Fertilizers
for soil injection and foliar application in Broadacre Crops

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Introduction

A new era of technologically advanced and highly efficient Granular and Liquid-Nitrogen bio-fertilizers is set to optimize crop performance.

After many years of development, Langley Fertilizers has recently released two cutting edge “slow release” Liquid-N products as part of its Troforte® Farming System –

1. Nitroforte™ Liquid-N IBS
2. Nitroforte™ Liquid-N Foliar - following on from successes in the horticultural industry.

Background

There is a general consensus that Nitrogen (N) management affects crop growth and development, and is intimately linked to the quality of crops. Research shows that N management of crops in an intensive farming system is uncertain, and often imprecise, due to various and fluctuating factors closely related to soil, weather, rate of plant growth and development, rotation, intended market, and also due to the unpredictable complex biochemical processes in different soil systems.

The underlying fact from a farmer’s perspective is that uncertainty in N management could be detrimental to farm performance, as under-fertilization causes profit losses due to unrealized yield and quality. On the other hand, over-fertilization causes lost profit due to the excess use of N and its negative indirect impact on soil health and crop physiology. Crop yield and profitability in terms of gross margins are two major considerations for the farmer. Small errors in N use may have little effect on profit - but repetitively larger errors each year can compromise farm performance.

In intensive farming, Nitrogen is commonly applied to soils, however, various research trials have shown that combining soil based N application with foliar N fertilization to correct these errors can improve crop quality and yield; and therefore improve Gross Profit margins for farmers.

There is no single strategy for N management to suit every farmer’s individual situation. However, supplementing a soil N application program (either with Liquid-N or solid N) combined with foliar N application, gives farmers more strategic N management options. It allows the farmer to “play the season” from an N perspective and takes the guess work out of matching nitrogen applications to yield potential.

Soil N Application

Application of soluble Nitrogen at higher rate to meet the crop N demands at various growth stages in agricultural soil is a common practice - but this may have negative consequences for soil-plant systems and can therefore give rise to physiological disorders, thereby affecting crop development, yield, quality and ultimately profit. Soluble N products with higher salt indexes have increased potential of causing crop injury and reduced germination. The higher the salt index of N fertilizer, the greater the potential of this fertilizer to damage an actively growing plant by removing water (dehydrating) from seeds/roots.

Trials have shown that excessive N application can also contribute to increased frost damage. Higher applications of Nitrogen fertilizer led to significantly higher frost damage, increased numbers of distorted grains and downgrading of wheat quality – ultimately leading to harvesting of lower profits. The key to ‘Managing frost - Minimizing damage’ is partially due to N management strategies.

Excessive application of water soluble nitrogen can have a negative effect on pH, Soil Health and deplete beneficial microbes and organic Carbon from soils.

In addition to this, N losses in a conventional fertilization regime, through leaching, Nitrogen runoff, volatilization, and denitrification are well documented - and can have negative environmental effects. These losses can be detrimental to crop quality and yield, primarily due to N unavailability at critical growth and developmental stages.

Foliar N Application

By “playing the season”, foliar application of nitrogenous fertilizers during critical growth phases can correct nitrogen deficiencies, improve Nitrogen Use Efficiency (NUE), decrease the total amount of N necessary, and minimize N losses. The timing of foliar applications will essentially depend on the specific goals of the farmer and the benefits that are desired. Foliar delivery of N has the potential to more rapidly overcome N stress, when compared to excess “upfront” in soil N application.
Crop foliage can absorb inorganic and organic nitrogen sources through microscopic pores within the leaf cuticles, or through the stomata. These pores can take up ammonium, nitrate and urea. They are lined with negatively charged molecules and therefore the uptake of small uncharged molecules, like urea, is rapid. The uptake of cations (such as ammonium) is faster than that of anions (such as Nitrates).

Urea is commonly used for foliar application because of its uncharged, high solubility and rapid absorbing properties. Its low toxicity potential when applied at low concentration to the leaves of crops, compared to other forms of N fertilizers, makes it a perfect choice for foliar N fertilization.

In a salt solution, Ammonium Nitrate is known to cause leaf scorch, whereas urea only causes light damage to the leaf tips. Exactly how much urea a farmer can apply depends on how much the foliage can tolerate without exhibiting urea toxicity. Toxicity to urea varies with species and leaf age due to the varying absorbing capabilities of different crops. The variation in the absorption of foliar N can be contributed to many factors, including the rate of application of N, the form of N applied, retention characteristics on the leaf, the plant species, temperature and moisture at the time of application.

Foliar solutions containing N salts quickly enter through cuticle pores and free water vaporizes into the atmosphere, leaving behind a large amount of phytotoxic mineral salts on the surface of the leaves. This may cause desiccation of the plant cells by osmotic stress (necrosis or localized tissue damage) as water moves out of cell at the point of contact, and renders the leaves incapable of absorbing the remainder of the nutrient salt. In the case of urea, excess application can lead to crystallized urea remaining on the leaves. This will hydrolyze into ammonia giving rise to phytotoxic effects (scorching), and the production of carbon dioxide, where it is lost to the atmosphere.

**Poor Nitrogen Use efficiency**

Research has shown that the Nitrogen Use Efficiency in conventional N management systems is relatively low (20-30% in wheat) and the benefit gained by using a combination of soil N and foliar N application in these situations, is far less. This could be primarily attributed to N unavailability during critical growth stages (N losses), coupled with initial higher salinity at the time of application (root desiccation and injury) in soil N application and foliar N application causing leaf damage/scorching resulting negatively on crop potential. Theoretically, greater benefits can be achieved by frequent soil N applications supplemented by frequent foliar N applications. However, this is a major management constraint and a challenge in intensive farming systems for cultivating crops economically.

**pH and Nitrogen**

Nitrogen containing inorganic fertilizers can contribute to soil acidification. The main cause of soil acidification is the excessive and inefficient use of nitrogen, followed by the export of alkalinity in harvested produce. Ammonium based fertilizers are major contributors to soil acidification. Ammonium nitrogen is readily converted to nitrate and hydrogen ions in the soil. Nitrates not absorbed by plants, can leach away from the root zone leaving behind hydrogen ions and thereby increasing soil acidity.

**Nitroforte™ Liquid-N - Part of The Answer**

Troforte Innovations Pty Ltd, trading as Langley Fertilizers, a Research & Development arm of Sunpalm Australia and innovator of the Troforte® Farming System, have developed the innovative and cutting edge proprietary Nitroforte™ Technology for Nitrogen use optimization on various crops. There are currently two “slow release” Liquid-N products available –

1. Nitroforte™ Liquid-I BS, and
2. Nitroforte™ Liquid-I Foliar.

Nitroforte™ formulations, contain a complex series of nitrogen molecules bonded with usable carbon. These are base catalyzed polymer condensation products of N molecules (and are not just simple fertilizer salt solutions) with resinous characteristics and fortified with essential amino acids and proprietary carboxylic acid salt (depending on formulation). The majority of nitrogen in Nitroforte™ remains in more complex soluble methylene and polyethylene N forms until broken down through microbiological activities (soil application) or photo-degraded (foliar application) into a plant-usable form of nitrogen.

The delivery of the “slow/controlled release” nitrogen in Nitroforte™ is essentially regulated by this mechanism. This also ensures no impact on soil pH and positive effects on soil organic Carbon.

Nitroforte™ formulations have an extremely low Salt Index (Salt Index 4 to 5, against 75 and 104 of Urea and Ammonium Nitrate respectively) which ensures that it can be applied safely - even at higher concentrations without crop injury.

1. Nitroforte™ IBS - Liquid seeder system

**Mode of Action (Soil Application)**

- Suitable for injection through liquid seeder systems;
- Ideal as part of a balanced fertilizer program for cereals and canola - may be applied at seeding, with solid compound fertilizers (such as Troforte® Farming System’s Cropping fertilizers).
- The normal release pattern of nitrogen in Nitroforte™ IBS is between 8 to 12 weeks.
- Nitroforte™ IBS is a uniquely developed liquid polymerized form of Nitrogen - and is fortified with Seaweed Extract and carboxylate. This unique process ensures that the N is bound in a complex “slow release” molecule - resulting in reduced volatilization and leaching losses; and no organic C losses or acidification issues.
- The biological decomposition of Nitroforte™ IBS, when applied to soil, requires micro-organisms to consume carbon, thus making the nitrogen plant available. The Carbon to Nitrogen ratio in this polymer is 1:1, and therefore provides an ideal

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As Nitroforte™ IBS is dispersed in the soil, a “wicking” action takes place that draws free water away from the nitrogen molecules - forming a more viscous ‘in soil’ nitrogen gel. This polymerizes into longer chain polymers which are substantially less soluble in water. As this occurs, warm temperatures (from 5 degrees Celsius), moisture availability, and especially microbial action all become necessary to convert the less soluble forms of nitrogen into a usable form of nitrogen in the root zone. Besides providing the well documented benefits of seaweed extract, carboxylate liberation in Nitroforte™ IBS through microbial degradation can also help in solubilizing mineral P and making it plant available - when crops need it.

Another possible pathway for its bio-stimulatory effect is the biological decomposition of carboxylate and production of plant growth regulating compounds. Biological decomposition of carboxylate containing Nitroforte™ IBS when applied to soil can produce Ethylene Gas, an established Plant Growth Regulator.

2. Nitroforte™ Foliar – Boom sprayer

Mode of Action (Foliar Application)
- Suitable for application through boom sprayer systems;
- Ideal as part of a balanced post-emergent N fertilizer program for cereals and canola – to boost production in seasons that require extra Post-N.

Nitroforte™ Foliar technology allows for a staggered release of nitrogen. In a normal, low volume foliar application of Nitroforte™ Foliar:
- Some of the nitrogen is available and can be found inside the crop within 6 to 8 hours of application.
- A high percentage of the nitrogen remains on the leaf surface until it is absorbed. Its sticky and resinous characteristics allow it to form a rain-fast coating onto the leaf surface that lasts for weeks and is photo-degraded for slow absorption.
- It does not hydrolyze the plant tissue, but readily crosses cell membranes into the plant, where it is translocated for storage, metabolism and use.
- Nitroforte™ Foliar’s extremely low Salt Index (Salt Index of 4 to 5, compared against 75 and 104 of Urea and Ammonium Nitrate respectively) ensures that it can be applied safely - even at higher concentrations without the fear of crop injury.
- The gradual and slow release of nitrogen from Nitroforte™ Foliar provides longer term availability of nitrogen to be absorbed by crops more efficiently and effectively.
- Increased Nitrogen Use Efficiency comes from the low molecular weight and smaller molecule size of the N (MDU 112 Daltons) and (DMTU 174 Daltons) contained in Nitroforte™ Foliar. The atomic mass limit for the passage of molecules through the plant leaf stomata is 800 Daltons and leaf cuticles is 300 Daltons. This ensures active and rapid absorption of the released N into the plant tissue.

Unique Features and agronomic positioning of Nitroforte™ Liquid-N:
- Optimum Nitrogenous Fertilization (gradual and slow release Nitrogen) for full and balanced crop development for superior harvest.
- Maximizes absorption and Nitrogen Use Efficiency (the nitrogen applied in traditional nitrogenous fertilizers can be reduced by 40-50% using Nitroforte™).
- Nitroforte™ slow release characteristics increase plant uptake of the N:
  - reduces losses through less leaching or volatilization;
  - doesn’t contribute towards acidification or environmental pollution or degradation;
  - enhances organic Carbon and microbial bio-mass in the soil.
- Has an extremely low Salt Index (4 to 5) and therefore optimizes crop yields and quality:
  - does not cause root injury or burns with soil IBS application.
  - does not cause desiccation or toxicity (leaf scorch) on crop leaves – therefore does not limit photosynthesis of the leaves.
- Limits the onset of fungus and defends against aphid attacks.
- Enhances the shelf life of crops and the production of dry matter by preventing the softening of tissues or flattening.
- The product can be mixed with herbicides and other macro and micro nutrients:
  - a jar test is recommended to check compatibility before mixing.
  - it is not compatible with strong acids and bases.
- Nitroforte™ liquids are suitable for application through liquid seeder systems (for soil IBS application) and also through boom sprayers (for foliar application).
- Nitroforte™ liquids are filtered to the finest degree and can therefore be mixed with other macro and micro nutrients for application through drip irrigation systems.

References

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