Exploring the potential of Ultra-High-Pressure UAN injection

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Urea Ammonium Nitrate (UAN) is a liquid nitrogen fertiliser that has been used extensively as a surface and foliar spray over established crops. In addition, farmers can broadcast urea over the top of the crop or apply nitrogen (N) into the soil using mechanical side-banding methods such as inter-row coulters.

The aim of this project was to assess the potential to use Ultra High Pressure (UHP) liquid injection technology to apply an ultra low soil disturbance UAN sideband into cropping soils and test whether UHP injection of UAN is a viable alternative N application method for the future.

Post-emergent nitrogen can be applied in many ways including by boom spray, mechanical side banding or UHP liquid side banding.

In particular, the trial assessed the nitrous oxide emissions from post-emergence N applications by comparing a nil treatment, a surface-applied UAN treatment from a regular low-pressure spray nozzle and UAN injected in to the soil at two ultra-high pressures; 25,000psi and 50,000psi.

All treatments were replicated four times in a randomised trial, with N applied at an early timing and a later timing.

Nitrous Oxide (N_2O) is a powerful greenhouse gas with a global warming potential that is 300 times more intense than carbon dioxide (CO_2).

Loss of N_2O from a cropping system means the crop is not utilising N that has been paid for by the farmer.

Two trial sites were established, a cool-season, high-rainfall cropping site near Salter Springs in SA and a warm-season cropping site at Wollongbar, in northern NSW.

The SA site was a in a zero-till paddock with full stubble retention.

The first question we wanted to answer was whether the UHP equipment would handle a solution of 50% water and 50% UAN. More robust durability testing of the UHP system relative to fertiliser concentration is still required, but the ultra-high-pressure pump, seals,

THE UHP JET, WHICH DID A GOOD JOB OF UAN INJECTION, CAN ALSO CUT THROUGH HEAVY SURFACE RESIDUE, THOUGH THAT WASN'T NEEDED IN THIS NSW CORN CROP.

connections and nozzles used were able to discharge aqueous N fertiliser reliably over the two year trial period.

Field observation suggests the 50% UAN solution produced a better stubble cutting action than water alone, most likely due to the higher density of the solution.

Emissions and crop performance trends showed glimpses of the technology's potential, but from a statistical point of view the data are not compelling enough

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to support claims of a significantly better outcome from UHP than from surface application of N. However, in most cases, the trends suggested that the UHP application was as good or marginally better than the traditional application method.

There are many interactions between N application rates and crop timing when applying N post-emergence, with yield and protein response to in-crop N a complex field of research in its own right.

To simplify interpretation of the trial results, total protein off-take (yield x protein) for each treatment was averaged across the four replications and the average used as a combined indicator of N efficacy.

This revealed differing responses from different treatment and application timing and further research is required to fully understand the mechanisms at play.

The NSW site was greatly affected by environmental conditions, including a drought and cyclone so the corn yield data from the trial is difficult to use with a high degree of confidence, but the high-pressure injection system performed well in the sub-tropical environment.

Cob yield following the UHP injection treatments was equal to that from the traditional N delivery system and better than late application of surface N in 2012/13.

Cob yield was lower in 2013/14, so few significant differences between treatments were observed. However, late application of N using 25,000psi resulted in significantly higher biomass production than surface application of N and the

highest cob production in the trial.

N_2O emissions were generally high for all treatments at the northern trial site in the first season due to an extremely high rainfall event resulting from Tropical Cyclone Oswald.

The Aqua-till N injection system has garnered interest from several industries including the sugarcane industry, where a more extensive assessment of impacts of deep placement of N is currently being undertaken.

The NSW Farming Systems Group (Sugarcane), together with NSW Department of Primary Industries, the University of Newcastle and Southern Cross University, received funding from the Australian Government through the Carbon Farming Futures Action on the Ground program to trial deep placement of N for reducing emissions of N_2O in collaboration with SANTFA. Six trial sites were established testing two promising technologies for improving N-use efficiency and lowering emissions. These treatments were a slow-release N fertiliser based on biochar and UHP injection.

Large differences in nett emissions were observed across the six trial sites, ranging from 1.5kg N_2O/ha to 74kg N_2O/ha over the 2014/15 summer sampling period and two of the six sites recorded significantly lower emissions of N_2O following deep placement of N fertiliser.

Work is underway to determine the extent of yield benefits and intensive sampling for greenhouse gas emissions continues. Biomass production will be measured and N-use efficiency calculated over the next two years.

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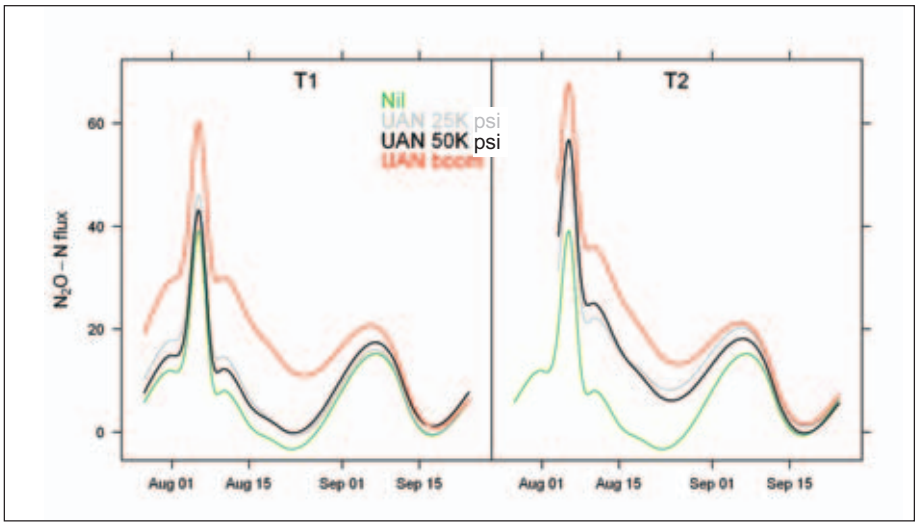
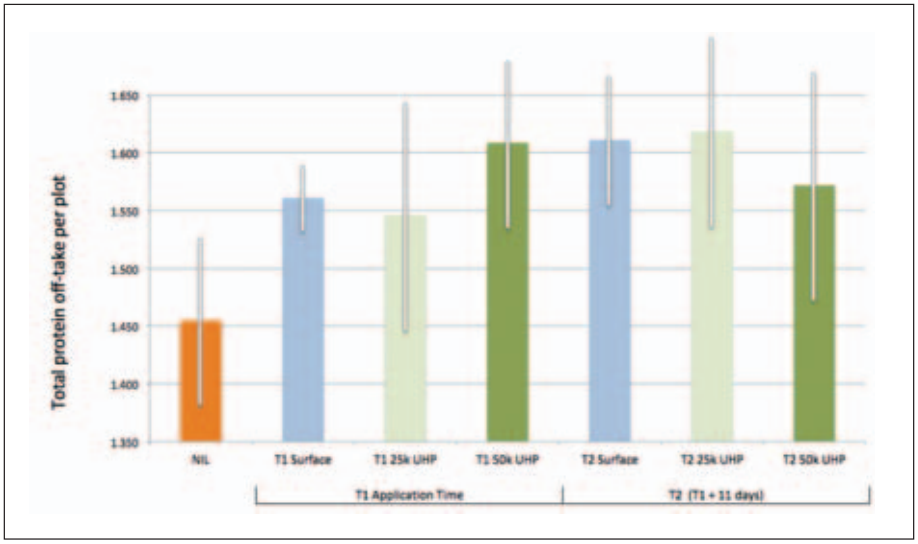
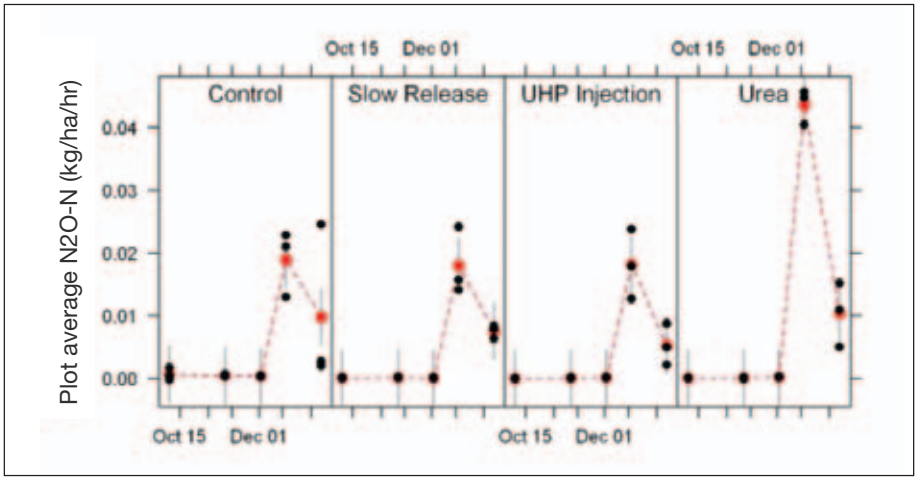


UHP APPLICATION COMPARED TO TRADITIONAL BOOM APPLICATION.
ALTHOUGH THE DATA WAS NOT STATISTICALLY ROBUST ENOUGH TO MAKE DEFINITIVE CLAIMS, THE N_2O FLUX WAS CONSISTENTLY LOWER WHERE UHP APPLICATION (UAN 25K PSI, UAN 50K PSI) WAS USED COMPARED TO THE TRADITIONAL BOOM APPLICATION (UAN BOOM) AT THE SALTER SPRINGS SITE.



WHEAT RESPONSE TO POST EMERGENT NITROGEN.
RESPONSE EXPRESSED AS TOTAL PROTEIN OFF-TAKE, (GRAIN YIELD X GRAIN PROTEIN) APPLICATION OF 50% AQUEOUS UAN AT TWO TIMINGS. 'NIL', 'UAN SURFACE SPRAY', 'UAN SOIL INJECTED AT 25,000 PSI' AND 'UAN SOIL INJECTED AT 50,000 PSI'.



FLUX OF N_2O FROM FOUR TREATMENTS.
CONTROL (NIL N APPLIED), SLOW RELEASE, UHP INJECTED AND FARMER-PRACTICE UREA. N RATES WERE MATCHED TO SUPPLY THE SAME APPLICATION OF TOTAL N PER PLOT.

LIQUID COULTER READY FOR IN-FIELD EVALUATION

Last season the SANTFA R&D team performed a liquid nitrogen side-banding exercise using Ultra-High-Pressure (UHP) water-jet nozzles.

The application was injected into the inter-row between growing crops but the cutting action through a significant layer of residual stubble was indicative of how well a UHP liquid coulter might perform at sowing time.

The first impression was how clean the cut was, with almost no hair-pinning even though the stubble was wet and ropey and the soil soft underfoot.

However, the positioning of the nozzle was super-critical to achieving a clean cut.

The UHP nozzle provided an impressive slice through stubble and into the soil when positioned close to the stubble surface and at a forward rake angle of 15°. The cutting action diminishes exponentially as the nozzle moves away from the stubble.

It is possible this technology could reduce seed-bed fertiliser toxicity due to the vertical distribution of the liquid stream, and while the initial trial did not assess sub-surface compaction, it is reasonable to suggest that cutting with water may have less soil compaction than mechanical cutting.

Because nozzle position is so critical to achieving the desired result we have developed a mechanism to maintain consistent ground engagement and this year will test and demonstrate the Aqua-Till system, which involves using the UHP nozzle acting as a liquid coulter in front of a sowing implement.

With the help of AgPoint Australia, SANTFA has designed and built a small Aqua-Till test bar on which the UHP nozzle is guided by a ground engagement wheel on a parallelogram assembly that will keep the nozzle within 10mm of the surface. The mechanism on the bar is designed to allow adjustment of forward or reverse rake angle and side-to-side angle.

This project is being supported by the Australian Government Department of Agriculture's Caring for Our Country Innovation program, Conservation Agriculture Australia, Flow Corporation and Agpoint Australia.

Three types of devices will be tested in conjunction with the Aqua-Till system: a knife point system, a disc system and an all-new ski system designed with small seeds like canola and clover in mind.

Demonstrations will be in the first week of May, with locations and times available on the SANTFA facebook page. Growers with the time available are encouraged to attend these demonstrations.

FIGURE 1: A 6T WHEAT STUBBLE COVERING MOIST, SOFT SOIL WAS SLICED CLEANLY WITH A 50% SOLUTION OF UAN.

FIGURE 2: DIGGING AWAY THE SOIL ON ONE SIDE OF THE UHP CUT SHOWED THREE KEY FEATURES: HAIR-PINNING WAS VIRTUALLY ELIMINATED, STRAW UP TO EIGHT LAYERS THICK WAS CLEANLY CUT, AND THERE WAS NO OBVIOUS STRUCTURAL DAMAGE TO THE SOIL OR SMEARING OF THE SIDE WALL.

FIGURE 3: THE AQUA-TILL ULTRA-HIGH-PRESSURE LIQUID CUTTING NOZZLE FITTED TO A PARALLELOGRAM SYSTEM IS TO BE TESTED AS A LIQUID COULTER IN 2015.