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Integrated Fertiliser Management

INTEGRATED FERTILISER MANAGEMENT AND ITS IMPACT ON FERTILISER USE EFFICIENCY AND YIELD

Efficient use of nitrogen in Australia lags behind the rest of the world

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What's in this Insight

This IN addresses the imperative facing Australian farmers to become more efficient with fertiliser use for their crops, especially for broadacre and field enterprises. The inefficient use of nitrogen in Australia is cause for concern and RLF's Integrated Fertiliser Management (IFM) program provides a valuable option to address this.

Background

This article written by Professor Peter Grace from Queensland University of Technology that appeared in ‘Farm Online’ issue date January 2017 reveals a big difference in efficiency of nitrogen use in Australian agriculture compared to that of the rest of the world.

As can be seen from the following data adapted from professor Grace’s article, efficiency of nitrogen use in Australia between 2010 and 2015 was 55% below the global average.

Global and Australian increase in nitrogen use and its impact on yield between 2010 and 2015

	Global	Australia
% Increase in Nitrogen Use	10	65
% Increase in yield	10	9

Professor Grace points out that the inefficiency of nitrogen use in Australia is a result of improper use of nitrogen, as well as poor retention of nitrogen by the ‘gutless’ Australian soils. He suggests that since aged Australian soils do not have the body to keep the nitrogen, greater run-off and more leaching results when 'a big whack' of nitrogen is applied.

Professor Grace explains further that due to the heavy mining of Australian soils during the period 1950 to 1980, farmers now have to use more nitrogen at a higher price which makes it difficult to maintain the bottom line.

The environmental damage of greater nitrogen loss is also pointed out by Professor Grace, which can be mitigated by proper fertiliser use that reduces nitrous oxide emission and leaching of nitrate especially in coastal sugar cane plantations. Nitrogen use efficiency can be improved by split applications of nitrogen to coincide with a period of rapid growth and nitrogen demand. It can also be improved by adding legumes in rotation, since it provides free and slow release nitrogen that if captured by proper rotation, results in increased farm profitability.

RLF Integrated Fertiliser Management (IFM) Practice

One noble way, in which fertiliser use efficiency can be improved, was proposed by RLF over 20 years ago as the three-pathways for fertiliser use referred to as Integrated Fertiliser Management (IFM). IFM is practised by many RLF clients in Australia and overseas.

In short, it is a method of fertiliser use that incites anatomical and physiological modification in crops, resulting in increased efficiency of fertiliser use. Numerous RLF Technical Bulletins describe the science and concepts involved in these modifications and they are itemised and described as follows:

1. BSN is used to prime seeds. The embryo perceives the high nutrient status and upon germination gives rise to uniform seedlings with a higher yield potential.

2. Root exudation starts sooner in treated seedlings, and at a greater pace. This is primarily due to the higher energy level generated by tripling the level of available (inorganic) phosphate in the primed seeds.

3. Rapid root elongation and activity allows the seedlings to access the starter fertiliser and soil reserves. This ensures that the higher yield potential set in primed seeds will be preserved by accessing soil and fertiliser reserves in time.

4. In order to allow fertiliser integration and root efficiency to progress, granular fertiliser input should not be excessive so as to prohibit root growth. As a rule of thumb, there is evaluated benefit in a 20% reduction of granular NPK to remove the heaviness and hazardous effect of high levels of NPK. This allows the roots to accomplish their new/acquired roles.

5. It has been shown in both cropping plants (Hermans et al 2006, Science Direct) and pasture species (Hill et al 2006, Plant and Soil 286, 7-19) that higher input of nitrogen and phosphorus allocates more carbon to the shoot at the expense of root growth. Therefore, the moderate use of phosphorus and potassium is prerequisite for typical and optimal root growth.

6. It is also known that when the phosphorus level is low or deficient, plants produce thinner and longer roots with more root hairs (Lambers et al, Annals of Botany 2006, 98, 693-713) thereby increasing nutrient uptake efficiency at a lower cost of carbon.

7. It is also a matter of documented record (e.g. Rawson and Macpherson, 2000 FAO publication) that early tiller establishment in cereal crops is associated with higher yield. The earliness of tiller appearance and completion in a treated crop compared to that of a control crop is easily demonstrated by the regular counting of the number of leaves and tillers in both the treated and control crops during early stages of crop establishment. RLF research has demonstrated that BSN seed priming treatment initiates early tiller formation in wheat and rice in replicated trials and on-farm evaluations. In a recent survey in South Australia it was noted that the size of the first tiller in wheat was some 40% bigger in BSN-treated crops than control. This was observed in a dozen plants randomly taken from each group – a good indication of early tillering induced by BSN seed treatment.

8. It has also been demonstrated in farmer trials, that the number of coleoptile tillers or crown tillers increase with BSN treatment. In a recent survey on one of these farms in South Australia, nine out of twelve (being 75%) plants had coleoptile tiller in the treated crop compared to five out of twelve (being 41%) in the control crop. Coleoptile tillers are known to be associated with higher yield in cereal crops as they function like a semi-attached sister-plant. Rebetzke et al (Aust. J. Agric. Res 59, pages 863-873) noted that coleoptile tiller numbers increased with nitrogen application. It should now be added to this observation that seed priming also increases the number of coleoptile tillers in wheat. These authors suggested that early leaf area development, and better competition with weeds, is also a factor in increased yield when coleoptile tillers develop.

9. The rhizosphere of the BSN-primed seeds form humic substances earlier, and in greater quantity thereby increasing mineralisation, ion retention and utilisation of soil reserves (nutrient and water).

10. RLF Foliar 1 (vegetative phase foliar) is recommended at early to mid-tillering on its own, or tank mixed with liquid nitrogen. It is a broad-spectrum Ultra Foliar specially formulated for the vegetative phase of field crops. Foliar 1 benefits the crop in following ways:

    a. Foliar uptake efficiency is a few folds better than soil uptake.
    b. Nutrients absorbed by leaves from foliar sprays, use half (or less than half) of plant energy compared to nutrient uptake from the soil. The saved energy can be used to produce more yield.
    c. The urea and ammonium sources used incorporate into amino acids and protein, saving the plant energy (ATP) that is otherwise used to reduce nitrate uptake from the soil.
    d. It contains nitrogen and phosphorus buffered in low pH. This increases root exudation since they stimulate photosynthesis, sugar transport to root and provide the energy and metabolite to stimulate root exudation. Root exudation is proven to unlock soil phosphorus in both acid and alkaline soils (Richardson et al 2009, Crop & Pasture Science 60; 124-143) maintaining the momentum of high yield that is initiated by seed priming.
    e. While soil nitrogen increases shoot dry matter as previously discussed, foliar nitrogen increases root dry matter. This is because a shortage of potassium (positive pair for nitrate ion) needs to be supplied from soil, and this requires more hydrogen ion pumping or root activity and growth. Hydrogen ions are believed to be involved in root elongation by loosening the cell wall linkages during cell expansion.

11. RLF Foliar 2 (reproductive phase foliar), that has a high phosphorus and potassium content with some trace elements are important during the reproductive crop phase. This completes the IFM practise ensuring that phloem mobility and transfer of plant reserves to grain progress efficiently in order that higher yield potential can be accomplished.

12. Application of foliar nitrogen is often preferred to soil application since it can be tank-mixed with pesticides and foliar fertilisers alike. Farmers now have the ability to foliar spray and squirt nitrogen into the soil in one operation for increased nitrogen efficiency. It also improves yield due to benefits of foliar fertilisers as discussed in earlier key points.

13. Nutrients taken up by leaves from foliar fertiliser, use 1/2 to 1/3rd of the energy that a plant uses to take up nutrients from the soil. This is because, when nutrients are absorbed by roots with the expenditure of ATP energy, they move across the root (some believe with expenditure of more energy) to xylem sap and reach the leaf free space where energy of ATP is again used to move these nutrients into the leaf cytoplasm.

14. RLF independent trials over more than a decade have established and proven yield benefits for seed priming and fertiliser integration to be many times more than the investment in seed priming and foliar crop nutrition products. Interestingly, IFM may not even add to the fertiliser budget since in many circumstances granular fertiliser input needs to be moderated to relieve the strain on root performance and to allow for the practice of IFM to deliver its full benefit.