TagTeam™ and JumpStart™ from Novozymes

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Take home messages

- *TagTeam™ has increased the yield of field peas by 4.5 percent in trials using half the rate of phosphate fertiliser, resulting in a productivity gain of at least $30/ha from both the yield increase and fertiliser reduction*
- *JumpStart™ has been shown to increase the wheat yield by 5 percent in farmer split-paddock trials where half the rate of the grower's fertiliser was used, resulting in productivity gain of at least $30/ha from both the yield increase and fertiliser reduction.*

In many soil types, phosphate fertiliser applied at seeding is rapidly bound to calcium, magnesium and iron minerals in the soil, making it unavailable to the seedling. Following research in Canada and Australia, Novozymes Biologicals Australia, formerly Philom Bios Australia, has developed two biological inoculant products able to solubilise phosphate from the soil. One product TagTeam™ will be available to growers in 2009, the other JumpStart™ is awaiting regulatory approval. Both products will contain the naturally occurring soil fungus *Penicillium bilaii*.

JumpStart™ contains only *P. bilaii* and is suitable for use in wheat, barley, canola and sorghum. It can also be used on legume crops grown in situations where there is a high level of available nitrogen or high rates of nitrogen fertiliser are used at seeding where there is no requirement or benefit of a rhizobium-based inoculant.

TagTeam™ is a multi-action inoculant that addresses both nitrogen and phosphate fertility by combining rhizobia (N Prove™) with the naturally occurring soil fungus, *P. bilaii*. TagTeam™ formulations will be suitable for use with field peas, lentils, faba beans, vetch, chickpeas and lupins.

Both products will offer the greatest potential in soils that tie up phosphate; activity is likely to be restricted in very sandy soils (>85 percent sand) and soils with very high organic matter (>14 percent). Responses have been recorded on calcareous sandy loam soils, alkaline clays and acidic soil types that have the ability to tie up phosphate. Where soil available phosphate levels are high or very high (> 40ppm Colwell P) there is the potential to replace some phosphate fertiliser with the TagTeam™ *or* JumpStart™.

How the inoculants work

As seeds germinate and develop a root system, the *P. bilaii* fungus and the plant form a mutually beneficial relationship. The fungus grows and multiplies along the crop root. It feeds on the root exudates and releases organic acids into the soil. These acids break the bonds holding the phosphate nutrient in a mineral form and, in so doing, convert the phosphate from a less available form into a form readily accessed by the plant. *P bilaii* also helps with the efficient conversion of fertiliser phosphate into useable forms available for plant uptake. The result is enhanced phosphate uptake that assists the crop to achieve its yield potential.

When the phosphate solubilising fungi is combined with rhizobia there are additional benefits. The increase in available phosphate also provides much needed energy for the nitrogen fixation process, so enhancing the relationship between the rhizobia and the legume.

Another benefit of the soil fungus in relation to rhizobia is that it enables more root hairs to develop. Each root hair is a potential entry point for the rhizobia bacteria. More entry points mean an increase in nodulation, nitrogen fixation and potentially yield.

The promotion of root growth makes the plant better able to access moisture and a range of nutrients, not just phosphate, so the plant is better able to withstand a variety of crop stresses, including short dry periods and seedling disease.

Benefits

By solubilising less available phosphate to a more available form, the fungi promotes greater phosphate use efficiency. In turn, this results in more rapid seedling emergence, early vigour, greater stress tolerance, and more even maturity. All of these can help promote yield improvements.

In western Canada, thirty seven split-paddock trials have shown a six percent increase in yield with this TagTeam™ in both field peas and lentils over a range of environments (www.bioag.novozymes.com). Two farmer split-paddock trials in field peas in Australia support this work by showing that TagTeam™ plus half the rate of fertiliser normally used increased yields by an average of 6 percent compared to a full fertiliser rate.

Thirty on-farm split-paddock comparisons (six legume, 24 cereal) as well as 39 replicated trials (23 wheat, six canola, six peas, four chickpea) were conducted in Australia during 2007 and 2008 using both TagTeam™ and JumpStart™ across all states and all key growing regions.

Two replicated experiments at Greenly, Eyre Peninsula SA, and Marrar, southern NSW, offer some insights into the effect of TagTeam™ in comparison to the traditional sole use of the same rhizobia product. In these trials, TagTeam™ was applied as a peat on seed at 2.45kg/tonne at to field peas with one of two rates of phosphorus fertiliser (5kg/ha P (equivalent to 25kg/ha MAP) or 10kg/ha P) as well as an untreated control.

The Greenly site had a soil $pH_{(water)}$ of 7, Colwell P of 16mg/kg, surface nitrate of 17.5mg/kg and total soil P of 259mg/kg. The Marrar site had a soil $pH_{(water)}$ of 5.6, Colwell P of 24mg/kg and surface nitrate of 40mg/kg. The trials were conducted by independent contractors. No difference in crop emergence was observed at either site with any treatment, but visually there was an average 5 percent increase in crop vigour and an average increase in crop dry matter of 10 percent in the TagTeam™ + 10kg P treatment compared to 10kg P alone at both sites (results were not statistically significant).

Figure 1 shows that over the two trials, TagTeam™ increased the field pea yield by eight percent at both rates of fertiliser. TagTeam™ with a seeding application of 5kg/ha phosphorus (equivalent to 25kg/ha MAP) gave higher yields (three percent higher at Greenly and six percent at Marrar) compared to 10kg/ha phosphorus (equivalent to 50kg/ha MAP) without the phosphate solubilising fungi. At these sites, the TagTeam™ as a seed treatment for field peas has the potential to reduce fertiliser phosphorous rates by at least 5kg/ha phosphorus or 25kg/ha MAP. This data demonstrates potential productivity gains for growers of $30/ha using TagTeam™ made up of $20 from the yield increase (4.5 percent average yield increase from a 1.5t/ha pea crop at $300/tonne) as well as a saving of at least $20/ha in fertiliser cost (reduced MAP rate by 25 kg/ha at a MAP cost of $800/t) subtracting the cost of the product. The cost per hectare of TagTeam™ varies with crop type and sowing rate, but for field peas sown at 100kg/ha, the cost is $9.50/ha using the suggested retail price for peat on seed. Pea rhizobium inoculants generally retail for around $5/ha.

When growers have soil test results and use TagTeam™, Novozymes suggests that the lower recommended phosphate fertiliser rate is used. In some situations, this could represent substantial saving in phosphorus fertiliser inputs.

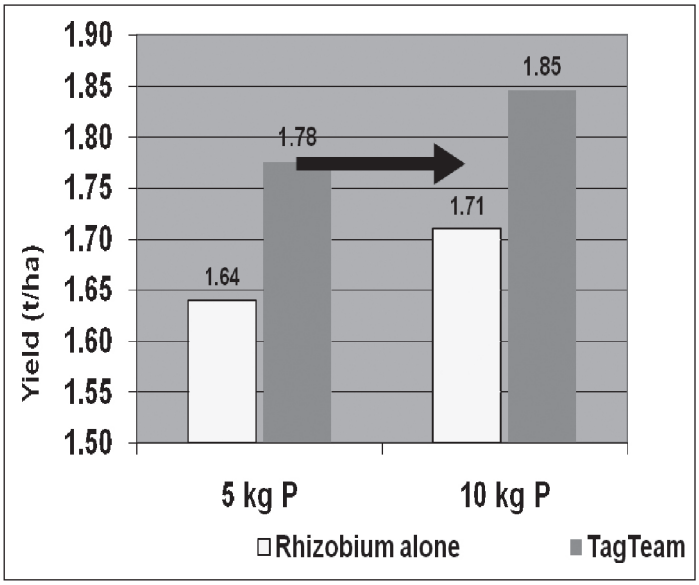

Figure 1. The effect of TagTeam™ compared to rhizobia alone on the yield of field peas (yields are averages of the two sites).

Delivering phosphorus via solubilisation of less available soil phosphates, rather than as high rates with the seed, provides a safer delivery method for phosphorus sensitive crops such as field peas, lentils and lupins, as fertiliser rates with the seed can be reduced while total available phosphorus is maintained.

Trials have been conducted in cereals as well as legumes. Six recently harvested split-paddock wheat trials using farmer equipment have shown an increase in wheat yield of 5 percent with JumpStart™ using half the normal rate of fertiliser used by the grower. This represents a productivity gain of $30/ha made up of $25 increased yield ($250/t at 2t/ha) as well as a saving of at least $20/ha in fertiliser cost (reduced MAP rate by 25kg/ha at a MAP cost of $800/t) subtracting the cost of the product. The cost per hectare of JumpStart™ varies with crop type and sowing rate, but for wheat sown at 80kg/ha, the cost is $12.50/ha using the suggested retail price.

Trials have demonstrated that phosphorus availability can vary by up to four-fold from the average over short distances. The use of TagTeam™ *and* JumpStart™ increase a plant's opportunity to access less available forms of phosphate, which has been shown to increased uniformity of crop emergence, development and maturity. Earlier, more uniform maturity often means earlier harvests and higher grain quality.

The products

The multi-action inoculant, TagTeam™, will be supplied as self-sticking peat formulations for seed coating and 'down the tube' granular formulations, and will contain the naturally occurring soil fungus *Penicillium bilaii* as well as rhizobium. The single action inoculant JumpStart™ only contains *P bilaii*.

As with other biological inoculants, these products contain live organisms and to remain viable the products and treated seed must be stored at less than 20°C, away from direct light and heat sources.

Different formulation of TagTeam™ have been produced for three different rhizobia inoculant groups, while the JumpStart™ formulation can be used across most broadacre crops.. The area covered by each container will depend on the crop type and sowing rate, eg. a container (80g) of JumpStart™ treats 20ha of wheat at a seeding rate of 80kg/ha. All these details can be found on the label or on the web www.bioag.novozymes.com.

Like rhizobia these inoculants need to be applied each year to ensure close seed-inoculant contact at high numbers.

Novozymes collaboration

Novozymes Biologicals Australia, formerly Philom Bios Australia, a joint venture company between the GRDC and Novozymes Biological Limited are developing a suite of microbial inoculant products for grain legume, cereal and oilseed growers with the aim of increasing their yields and profits. The first inoculant to be launched in 2009 is a product called TagTeam™.

Research collaboration between CSIRO Entomology and the GRDC-Novozymes joint venture continues to develop new generation phosphate solubilising inoculants adapted to Australian agri-ecological conditions.

The successful adoption of these elite inoculants requires a thorough understanding of their ecology in cropping soils, including information on factors affecting their abilities to solubilise poorly available forms of soil phosphate, actively colonise growing roots and proliferate within the root zone.

The research is improving prediction of inoculation responses and will help better target inoculants to particular cropping conditions with the objective of providing a range of industry benefits.

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