Fertiliser Placement

FerTill™:

The Theory, The Science, The Results.
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Overview:
Banding phosphorous in a tight zone in the soil makes more P available to the plant in the early stages of growth. Creating a zone of low soil strength deeper in the soil encourages plants to grow to a greater depth where more soil moisture and applied fertilisers are available. However placing some P fertiliser in the seed row is important.

Conventional broadcasting of urea N in front of the seeder has consistently achieved poorer grain yield and protein results compared to one pass banded N below the seed row. Pre-drilling of urea N has consistently given poorer grain yield and protein compared to one pass banded N below the seed row on all alkaline soils 350 - 425 mm annual rainfall. Banding all the P fertiliser below the seed row can reduce grain yield and protein on alkaline duplex soils of 400-425 mm annual rainfall.

Zinc has been an essential factor in maximising grain yield at all sites. Increased wheat grain yield of 4-6% has been achieved with zinc applied as a coat to DAP applied in each year.

There has been very mixed results from urea N application in barley at all sites except a highly calcareous loamy sand site at Ardrossan where there has been significant economic benefits from banded N.

There have been considerable advances in tillage and seeding technology in the last decade. The most significant of these advances is in fertiliser placement technology, which has occurred in the last three to four years. Farmers now have the ability to accurately place fertilisers in a band either in the seedbed or below the seedbed in a one pass seeding operation.

Where Is Phosphorus Applied In The Soil?
Available soil phosphorus has become stratified in the soil seedbed over time (Table 1).

Both the depth and amount of soil cultivation have determined the relative concentration of available soil phosphorus in these stratified layers. There has been significant reduction in the amount of conventional tillage practiced, and in an increasing number of cases the complete change from wide cultivation shares to narrow cultivation and seeding points. As a result, both the depths to which applied soil phosphorus is worked into the soil and the relative spread of phosphorus fertiliser in the soil has changed. The stratification of available soil phosphorus will increase as farmers progressively reduce the amount of soil tillage and use narrow seeding and tillage points more often. Research in Australia suggests that the distribution of soil nutrients in the plant root zone is an important factor in maximising grain yield potential.

Table 1. Average extractable P (Colwell) concentration (mg/kg) at depth on a **range of SA soils.**

Depth (mm)	Loam red-brown earth (15 sites)	Loamy sand (3 sites)	Sand (4 sites)
0-30	42	29	22
30-60	36	28	20
60-120	22	15	15

How Phosphorus And Nitrogen Uptake Is Affected By Placement

Most of the phosphorus fertiliser applied to a cereal crop is taken up in the early stages of crop growth. In popular fertiliser banding systems, phosphorus is applied in a tighter zone in the soil. Less fertiliser granules are in direct contact with the soil as compared with broadcasting in a wide band either in the soil or on the soil surface. The net result of this is practice is allowing more of the phosphorus to be available to the plant in the early stages of plant growth.

Plant roots tend to grow in the path of least resistance. Fertiliser applied close to the soil surface is often unavailable to the plant if the soil surface dries out. Root growth as a soil surface dries out will tend to follow the moisture to depth. If fertiliser placement is too great a distance from the seed row, particularly with relatively immobile phosphorus, this significantly reduces the chance of the roots being able to efficiently utilise the applied nutrients. Creating a zone of lower soil strength deeper in the soil, combined with a concentration of nutrients placed at the base of this zone, encourages plant roots to grow to greater depth where there is often more soil moisture and a higher chance of finding applied fertiliser.

Nitrogen applied in a concentrated zone will cause an area of localised acidification as ammonium compounds are nitrified. This can induce a slow N release effect with urea as the localised acidification causes a reduction in the activity of the urease enzyme in the soil that converts urea to ammonium. Manipulating pH in the fertiliser zone to reduce the rate of phosphorus tie up with the soil such as when ammonium compounds are nitrified, may lead to possible increases in phosphorus availability during the early stages of plant growth on a neutral to alkaline soil. Maximum phosphate availability to plants is obtained when the soil pH (in water) is maintained in the 6.0-7.0 range. Nitrogen placed in combination with other nutrients such as phosphorus and zinc will stimulate increased uptake of these nutrients due to a proliferation of root development where high nitrate availability occurs. The greater root proliferation will increase the amount of root contact with these nutrients due to increase in both numbers, length and thickness of plant roots.

Canadian seeding equipment has had a great influence on the direction we have taken with seeding technology in Australia. Many farmers and researchers both in Australia and in North America are questioning the current farming industry trend of banding <u>all</u> N and P fertiliser below the seed at seeding. This is surprising, as there is considerable data from research experiments in Canada to suggest that some P should be applied in when banding fertiliser is a simpler system but perhaps not the most effective.

Improved tillage and seeding technology has changed our farming systems. The use and effects of these new technologies must be considered in future research. What is clear is that phosphorus fertiliser research must be carried out in a multiple nutrient combination to maintain a balance of crop nutrition and identify any synergy of response or limiting nutrient factors.

Why Consider Improved Fertiliser Placement?

Many farmers are asking themselves, "What are the benefits of banding P, N and other nutrients in a one pass seeding system?" The majority of new seeding equipment purchased over the last 3-4 years capable of banding N and P fertilisers are 2 tank air carts with one of these tanks delivering a blended mixture of fertiliser either all with the seed row or all below. The increased use of these types of machines over the last 2 seasons has rung a few alarm bells to scientists and farmers alike, questioning the effects of no P fertiliser in the seed row. Operation FerTill™ aims to give some answers to this question.

Key Principles Of Optimum Fertiliser Placement

Operation FerTill has measured grain yield in wheat sown in rotation over 3 seasons. A protein yield index which represents the yield (kg) x protein (%) gives greater indication of fertiliser efficiency to grow grain yield and protein. Three years research with Operation FerTill™ has determined the following basic principals:

- **Banding all the Phosphorus fertiliser below the seed row can reduce grain yield**
  In a number of cases, particularly on alkaline duplex soils of 400-425 mm annual rainfall, wheat and barley grain yields were significantly higher when phosphorus (P) fertiliser was applied in the seed row or at least some was applied in a split banded application compared to banding all the phosphorus fertiliser with the nitrogen fertiliser. (Figures 2, 4 and 5) The use of ribbon seeding techniques with a higher seedbed utilisation % (SBU %) may be a useful method to achieve the same result (see article on SBU technology).

  Placing some P fertiliser in the seed row becomes more important to maximise grain yield when Rhizoctonia patch is present or higher urea nitrogen (N) rates are used.

- **N efficiency is improved by banding N compared with pre-drilling N or incorporating N by sowing**
  Where increased nitrogen levels are required at sowing, urea N should preferably be banded in a one pass seeding operation where accurate placement ensures seed and urea separation. Maximum grain yield has been achieved with one pass banded N on all alkaline soils of 350-425 mm rainfall (Figures 1-2 and 4). On higher rainfall acid soils (Figure 3), broadcast N in front of the seeder has achieved poorer grain yield and protein results compared to pre-drilled or banded N (which achieved similar results).

- **Keep nutrients in balance**

Improvements in fertiliser placement, seeding technology and increased rates of fertiliser will only pay dividends when nutrients are kept in balance. Zinc (Zn) has been shown to be a clear limiting factor in achieving maximum fertiliser response from nitrogen and phosphorus on all soils sown in the SA Operation FerTill™ experiment program (Figures 1-4). Increased wheat grain yield of 4-6% has been achieved with Zn as a coat to DAP applied in each year over 3 years. This clearly questions the current practice of Zn application once every

3-4 years. These results suggest that Zn when used in combination with higher P and application should be considered every year N rates.

Figure 1. 1997-1999 Wheat results 350 mm annual rainfall alkalin calcareous soil sites (Ardrossan and Lochiel SA)

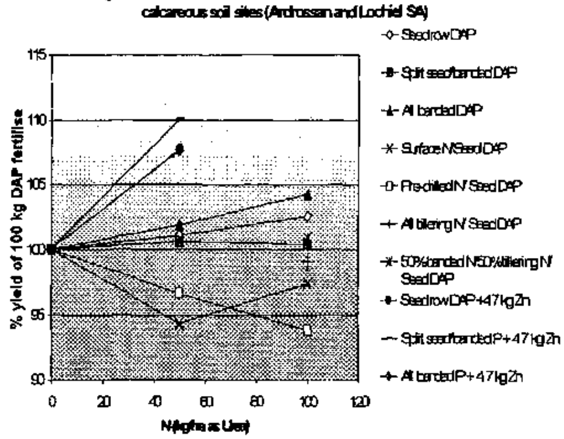


Figure 2. 1997-1999 Wheat results 400-425 mm annual rainfall alkaline duplex soil sites (Halbury and Hart SA)

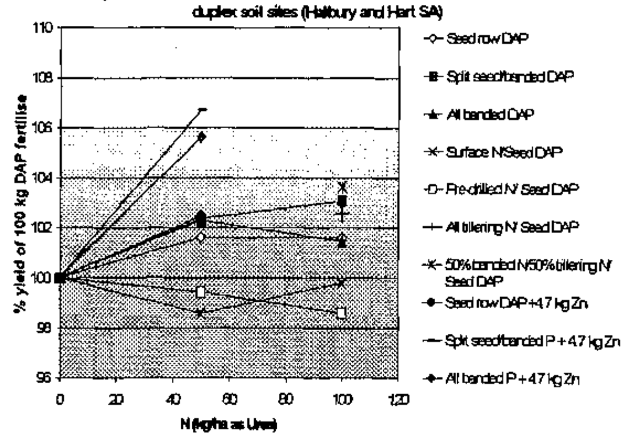


Figure 3. 1997-1999 Wheat results 450-550 mm annual rainfall acid soil sites (Marrabel and Mintaro SA)

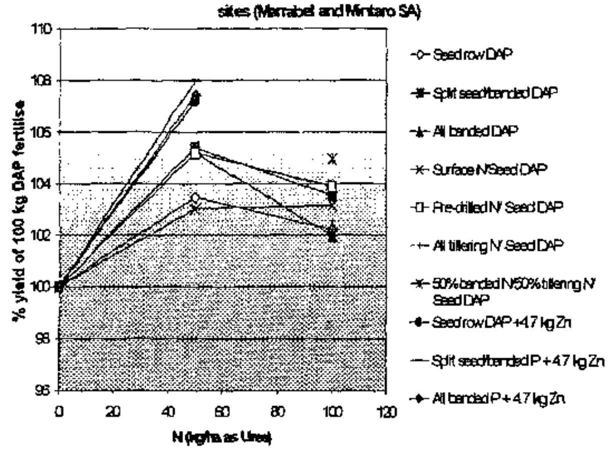


Figure 4. 1997-1999 Wheat protein yield index results 400-425 mm annual rainfall alkaline duplex soil sites (Halbury and Hart SA)

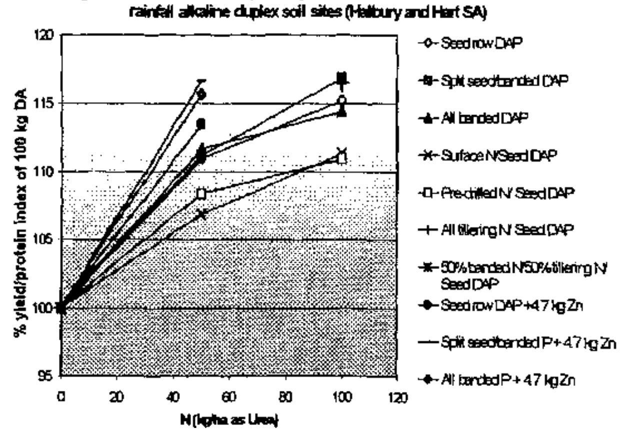
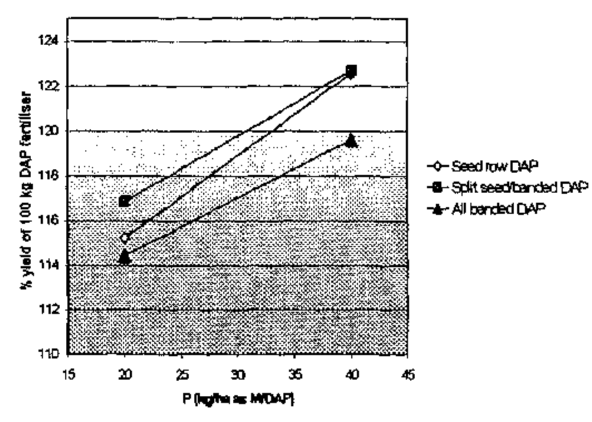


Figure 5. 1997-1999 Wheat protein yield index results 400-425 mm annual rainfall alkaline duplex soil sites (Halbury and Hart SA)



Other Operation FerTill™ Research Findings

There are other factors that should be considered for optimising fertiliser placement. Many of these factors have been highlighted by Operation FerTill™ research.

Improved fertiliser placement can reduce Rhizoctonia patch.
P and Zn placement are very effective management tools to reduce the severity of *Rhizoctonia spp,* in crops. Some P and *Zn* placement in the seed row of cereal crops is beneficial in reducing the severity of Rhizoctonia patch by up to 50%, increasing grain yield.

Fertiliser placement and tillage systems **can affect weed establishment.**
Combined effects of tillage, N and possibly P placement, has had a significant effect on brome grass establishment and growth on a calcareous loamy sand soil. Banding of N and P in combination with a one pass seeding operation has significantly reduced brome grass establishment after 2 years by over 50% compared with surface applied N or pre-drilled N which tends to mix the N into the soil close to the soil surface. This reduction in brome grass numbers in combination with other management techniques will enable cereal production to continue without significant complications.

Accurate seed placement is still important!
It is important to remember what the primary objective of seeding equipment is. Some farmers have been disappointed in the overall performance of banding fertiliser due to poor seed placement. Seed placement should not be compromised in the process of trying to achieve the benefits of a one pass seeding and fertiliser banding system. There are currently only a few commercial fertiliser banding/ seed placement systems available, which handle our abrasive soils and give adequate seed and fertiliser placement. A number of farmers have opted to manufacture their own fertiliser banding adaptors, which is a very time consuming option. There are however many new commercial models in the pipeline for release.

Definition notes:
Broadcast or surface N is when urea N is applied to the surface and worked in with a tillage or seeding operation.
Pre-drilled N is when urea N is drilled into the seedbed in a separate tillage pass prior to seeding.
Banded N **or P** is when urea N is placed apploximately 5 cm below the seed row in a one pass direct drill seeding operation.
Split seed/ banded DAP is when di-ammonium phosphate (DAP) is split 50% with the seed row and 50% banded with urea N.

Further Information
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