USING FERTILISER TO BEST ADVANTAGE - WHAT, WHEN, WHERE AND HOW MUCH ?

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The objective of this paper is to provide an overview of pasture fertilisation. It is clearly not within the scope of this paper to provide a comprehensive literature review of the topic, however, given the limitations of space and bearing in mind the practical nature of this conference, it is hoped to provide useful information on the topic and stimulate further discussion.

ESTABLISHMENT OF PASTURES

Adequate nutrition is a vital component of pasture establishment. Note, that no mention is made of germination where a seed requires factors other than nutrients such as moisture, temperature etc., to begin the germination process. Very soon after a seed germinates, the search for plant nutrients commences. By way of example, perennial ryegrass exhausts its seed nutrients reserves between the 7th and 14th day after germination (Anslow 1962) and subclover seedlings require nutrient from sources other than the seed by the 10th day after germination (Krigel 1967).

It is evident that seedlings of both grasses and legumes need to be supplied with adequate levels of nutrients very soon after germination. This applies particularly on lower fertility soils, but the need still exists on the higher fertility soils, including those of basaltic origin.

(a) Major nutrients

Phosphorus is more effective in assisting early development of pasture seedlings than nitrogen or potassium. Research and experience also show that small amounts of nitrogen and sometimes potassium combined with phosphorus can be more effective than phosphorus alone. This effect is frequently seen in many commercial situations. A note of caution is appropriate regarding nitrogen for legume establishment, since excessive rates of nitrogen may depress early legume growth (Campbell 1968). In general, 30 kg/ha of nitrogen is considered to be the upper safe limit.

Many research projects, confirmed by extensive landholder experience show the value of substantial inputs of phosphate at the early stages of pasture establishment to boost the performance of the legume component. This strategy hastens the clover dominant stage and arrives more quickly at a stable perennial sward (Wolfe and Lazenby 1973) Rates of superphosphate to achieve these objectives should be in the order of 375 kg/ha in the first 18 months.

(b) Fertiliser placement

Correct placement of fertiliser is an important factor in promoting early growth and development for one or more of the following reasons, depending on soil type.

- to ensure rapid and vigorous development of young seedlings.
- to ensure that plants have access to sufficient nutrients. throughout the growth cycle.
- to prevent damage to the seedling from salt injury, release of ammonia or some other cause.

- to minimise the fixation of nutrients, particularly phosphorus.

More efficient use of fertilisers can be made by band placing grass and legume seed with fertilisers. New Zealand research found that 125 kg/ha superphosphate drilled in close proximity to seed was as effective as 375 kg/ha broadcast at the time of sowing. This effect is frequently seen under NSW conditions and is more pronounced in soils of low fertility. Band placement of fertiliser just below and sometimes to the side of the seed mixture is recommended to achieve early seedling vigour and minimises any toxic effect that can occur when seed and fertiliser are placed together. Such toxic effects are more likely in dry soils and where urea or di-ammonium phosphate are used.

In practice, many producers will not have a machine that provides precise placement of seed and fertiliser.

(c) **Fertiliser type**

The type of fertiliser used when sowing a pasture can significantly influence subsequent development. Traditionally, single superphosphate has been used for pasture sowing and undoubtedly will continue to be important in the future. This recognises the severe and very widespread deficiency of phosphorus at many locations across NSW and the need for this nutrient to stimulate early root development, leaf expansion, tillering etc. Doubtless, some of the responses attributed to phosphorus would also be due in part to the sulphur component of superphosphate In fact, on some of the basaltic soils with an extremely high phosphorus status, sulphur is the more important of these two elements.

Starter fertilisers are not used to any appreciable extent compared with superphosphate for pasture sowing, chiefly because of the greater cost. Despite this, starter fertilisers can be useful. Because of their nitrogen content, they frequently give quicker establishment of pasture seedlings, provided other factors such as temperature, moisture and weed control are adequate.

Examples of starter fertilisers and their elemental analysis compared to superphosphate products illustrate this statement. (table 1).

TABLE 1. Elemental analysis of some common fertilisers

Product	Analysis %			
	N	P	K	S
Starter 12R (MAP)	12.4	22.3	0	3.0
Starter 15R	15.0	13.1	0	10.3
Starter 18R	17.5	8.0	0	16.9
GreentopR	19.1	5.2	0	21.1
Starter NPR (DAP)	20.0	19.0	0	3.0
Single superphosphate	0	9.1	0	11.5
Double superphosphate	0	17.5	0	4.5
Tri-FosR	0	19.4	0	2.0

It can be seen from these figures, that Starter 15R contains about 1.5 times as much phosphorus as single superphosphate in addition to 15% nitrogen. This nitrogen would be a very useful boost for early grass development, particularly if concentrated by a band seeded technique for quick access by the newly developing root system.

Single superphosphate at a rate of 120 kg/ha (the 'traditional' rate) could be compared with 83 kg/ha of Starter 15[R] to supply the same amount of phosphate, with the addition of 12 kg of nitrogen. The sulphur deficit would be small and be unlikely to cause problems under most circumstances. The cost of 120 kg of single superphosphate per hectare is currently $21.84 ($182.00/tonne in bags) and the 83 kg/ha of Starter 15[R] is $31.70 ($382.00/tonne in bags).

Starter 12[R] is also used for pasture establishment and the equivalent rate of the product (to provide the 10.8 kg P from 120 kg of single superphosphate) would be 49 kg/ha at a cost of $21.75. This is the same outlay as 120 kg of single superphosphate with the bonus of 6 kg of N and a reduction in handling, carting and the time required for refilling the combine. The sulphur content of Starter 12[R] is negligible at this rate, but may not be a problem where a significant quantity of superphosphate has been applied in the past. In addition, physical soil preparation, as distinct from direct drilling would be expected to mineralise organic sulphur reserves, at least for short term requirements until topdressing with superphosphate of the young pastures occurs.

Where heavier rates of high analysis fertiliser are used, the residual value should not be completely ignored. However residual effects are difficult to compute and equally difficult to build into a fertiliser budget.

Apart from the cost analysis of comparing various fertiliser types for pasture establishment, the important point to stress is the effect on seedling growth and vigour. The interaction of relatively small amounts of nitrogen and typical rates of phosphorus band placed with seed is important and provided other factors for favourable pasture establishment are met, the use of starter fertiliser at this early and important stage can frequently be recommended.

(d) Trace elements and lime

Trace elements and lime can have vital roles in pasture establishment. The role of lime will not be covered to any extent in this paper, there being plenty of excellent reviews and recommendations readily available. However, much of the pasture sowing activity conducted in NSW occurs on acid soils where lime at sowing can significantly enhance early growth. So too will the addition of the most commonly deficient trace element, molybdenum.

Interestingly, an interaction between lime and molybdenum can occur, as reported by Spencer and Roe (1962). These workers reported their findings from a series of experiments investigating pasture establishment on a low pH soil(4.8-5.2 in water) and a range of species expected to be suitable for the area. They found that lime had a marked ameliorative effect on the soil, and this effect operated in several ways; through improved nodulation of legumes, through release of native, previously unavailable molybdenum and through increased availability of nitrogen. They reported a differential response to molybdenum at different levels of lime and this is of particular relevance to early pasture seedling growth. In the absence of lime, nodulation was defective so that there was little demand for and little response to molybdenum by the plant. When sufficient lime was added to improve nodulation, there was a large demand for and response to molybdenum. With larger additions of lime so that the soil was appreciably less acid (above pH 5.5) there was no response to molybdenum and it was concluded that sufficient had been released from soil forms. In part, this research confirmed *inter alia* the desirability of using Mo-superphosphate on low pH soils as well as lime in establishing grass/clover pastures. While this work was conducted on the Northern Tablelands, similar results have come from the Central and Southern Tablelands.

The use of lime/superphosphate mixtures on acid soils is recommended to assist in the early establishment of legumes and some grasses.

Relatively small amounts of lime/superphosphate drilled with the seed has the effect of concentrating the lime in the drill run, improving the micro environment for early root development. While this is a relatively expensive product, it can well be a worthwhile investment to ensure good establishment in acid soils.

PASTURE MAINTENANCE

Many factors influence the persistence, vigour and integrity of a pasture, but the maintenance of adequate levels of plant nutrients is at least as important as any other factor. Grazing management, weed control and the presence of a dense competitive sward all strongly interact with plant nutrition.

Declining levels of the major nutrients will soon lead to a weakening of the pasture and subsequent weed invasion and a marked reduction in livestock performance (the bottom line in all pasture considerations). Hence the importance of maintaining adequate levels of major nutrients and some trace elements for pasture persistence. The loss of nutrients by leaching and through animal product has been studied by various workers and it is possible, under controlled experimental conditions to monitor quantitatively the loss of phosphorus the most commonly deficient nutrient from a grazed pasture. Under such conditions a fertiliser programme to maintain nutrient levels for sustained plant growth can then be formulated taking into account soil type, buffering capacity, physical factors and animal enterprise (Blair, Till and Smith 1976). However, under field conditions with different stocking rates, animal enterprises and indifferent record keeping, such an approach is unlikely to be attractive or indeed practical for most producers. The principles established by research are however of significance and can be used to bring about greater efficiencies in fertiliser usage.

In practical and commercial situations, the factors that need to be considered in a topdressing programme, and to determine priorities are:

- botanical composition of the pasture.
- soil type, buffering capacity and fertiliser history.
- animal enterprise and intensity.
- soil analysis.
- economic factors.

Clearly, the presence of responsive species is important, with greater efficiencies expected where introduced legumes and grasses are present in a pasture. In their absence, a more comprehensive pasture improvement programme would be recommended to correct this deficiency. Increased recognition is being given to the better quality native grasses and their use can result in improved levels of pasture and animal production in the absence of the temperate perennial grasses, commonly used throughout the higher rainfall areas of NSW. Under these circumstances, the integration of controlled grazing management with a fertiliser programme will produce good results (Robinson 1983).

Soil analysis for determining phosphorus deficiencies is a vexing topic, but should not be discarded through frustration or indifferent results. Indeed, the regular monitoring of soil phosphorus levels is recommended to maintain an on-going assessment of the phosphate status of pasture soils (Duncan 1980). This technique involves permanent soil sampling points strategically located across a paddock or property, where regular annual sampling takes place over a period of 3-5 years and thereafter when necessary. In this way, error due to spatial variability is reduced and a more accurate assessment of phosphorus status and fluctuation is possible.

Economic considerations are frequently the overriding factor in determining a topdressing maintenance programme, after consultation with an accountant or bank manager. As a result, efficiencies in fertiliser usage are not always achieved, although it is recognised that taxation considerations are frequently important and certainly need to be taken into account.

In an attempt to maintain pasture production and some stability of animal production, research and extension agronomists frequently establish a fertiliser application priority list to assist landholders determine where fertiliser should be used under circumstances of limited funds. Any such list must recognise the needs of the species present and the costs of pasture renovation should the fertility demanding introduced grasses and legumes fail to persist because of declining soil fertility.

An example of a superphosphate topdressing priority list is:

Priority 1: Newly sown pastures with a balance of grass and legume, in the development phase on soils of moderate to low phosphorus status.

Priority 2: Established pastures where the botanical composition is considered to be adequate and phosphorus levels are below the critical level for plant response. Soil analysis and strip tests can assist in these areas.

Priority 3: Previously topdressed semi-improved pastures with a good legume component and the presence of the "better" native grasses.

Priority 4: Previously unsupered native pastures. While topdressing of these areas will undoubtedly improve production, the response magnitude is usually only moderate to low and for this reason, a low priority is assigned to these areas. However, it should also be recognised that heavier dressings along with some clover seed will often produce worthwhile results within 3-4 years.

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