The nutrient needs of small-seed crops: a new concept in optimising seed yields

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Abstract

Until recently, fertiliser trials with small-seed crops have been concerned with relating rates of fertiliser to maximum seed yields, with little acknowledgement for the nutrients provided by the soil or atmosphere. This paper discusses the development of a diagnostic tool (calibrated herbage analysis) that will allow growers of small seed crops to assess the nutrient status of their crops at an early stage of growth and to correct any deficiencies identified in time to optimise production in the current season.

Additional key words: *Fertiliser, calibrated herbage analysis, nitrogen*

Introduction

Growers of small-seed crops have been assisted in their management practices by results from research trials of increasing sophistication since the 1940's. However, although the methods used, particularly with respect to statistical interpretation, have improved, research concepts have changed little since that time. Fertiliser trials, for instance, are still based on applying several rates of fertiliser to plots, and identifying the rate at which the highest yield at harvest is produced. Results from this type of trial are subject not only to changes in the weather, but also to the effects of the soil and atmospheric conditions; the capacity of the soil or air to supply whatever nutrient is under investigation affects the results, rendering these results site specific. With elements such as nitrogen (N), which is the most important element in cropping in New Zealand, it is extremely difficult to quantify in advance the soil's contribution during a growing season. Estimates vary from 60 - 105 kg/ha of N (White 1990). As results from one site cannot be applied to another site with confidence, it is possible that current fertiliser advice is under- or over-estimating fertiliser requirements for farmers, either of which can be costly. The alternative approach is to apply the theoretical requirement of the crop - which for ryegrass is usually taken to be 130 Kg/ha of N (Hampton *et al.* 1983). In this respect, seed production techniques have not kept up with advances in pastoral agriculture.

In the late 1970s and early 1980s Cornforth and Sinclair (1982) pioneered a fertiliser advisory service for pastoral farmers based on dry matter yield response curves using the nutrient solutions developed by Smith *et al.* (eventually published in 1983 and 1985). They calibrated these curves against the nutrient concentrations of the herbage and were able to identify the range of nutrient concentrations at which production was optimum. The Ministry of Agriculture and Fisheries' Fertiliser Advisory models were based on adding sufficient fertiliser to keep the pasture within the optimum nutrient range at the farmer's preferred stocking rate.

The concept of optimum nutrient concentrations has also been applied to various horticultural crops such as kiwifruit, asparagus and chrysanthemums - but it is not available for small-seed crops. As the guide lines for optimum nutrient concentrations for ryegrass are different from those for cereals the small-seed growers are in a quandary - in growing a grass for seed should they be following recommendations for grass (perennial but vegetative) or cereal (annual but reproductive) growth?

Strategy

In a preliminary trial using Grasslands Tama annual ryegrass (*Lolium multiflorum*), Rowarth *et al.* (1993) grew plants in 4 l pots in ambient conditions from sowing to seed harvest. The plants were watered with one of ten different nutrient solutions containing concentrations of N ranging from 32 to 907 μg/g. Herbage was cut from half of the pots (five at each nutrient concentration) in spring and analyzed for N.

Herbage N concentration in spring was correlated not only with dry matter production (Fig. 1), as found by Smith *et al.* (1985), but also with ultimate seed yield (Fig. 2). Over the range of herbage N concentrations produced the response curves (Mitscherlich) fitted to the relative dry matter yield and relative seed yield data differed significantly (Fig. 3), indicating that it is inappropriate to use fertiliser recommendations for ryegrass pasture (largely *Lolium perenne*) on winter-sown Italian ryegrass seed crops. By extrapolation, 90 % maximum seed yield was achieved with a spring herbage N concentration of 3.36 %; this compares with recommendations for ryegrass pasture of 4.5 - 5.0 % and for cereal of 2.1 - 3.0 % (Cornforth 1984).

The trial was repeated with perennial ryegrass in an attempt to reach a maximum in seed yield. Again the relationships obtained between herbage N % and relative dry matter, and herbage N % and relative seed yield differed significantly. Furthermore, seed yield was more sensitive than dry matter yield to change in herbage N % (Fig. 4). However, although herbage N concentrations

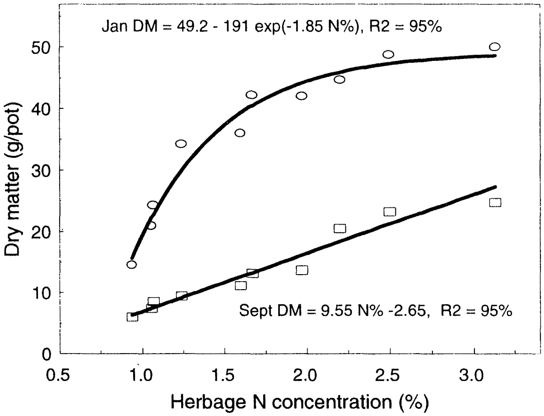

Figure 1. The effect of spring herbage nitrogen concentration (N%) on dry matter (g/pot) of *Lolium multiflorum* in spring (September) and summer (January).

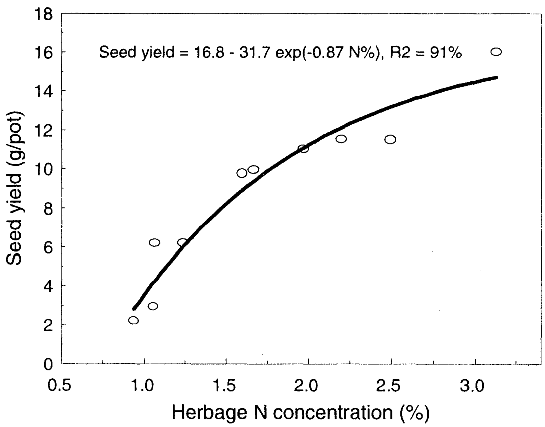

Figure 2. The effect of spring herbage nitrogen concentration (N%) on seed yield (g/pot) of *Lolium multiflorum*.

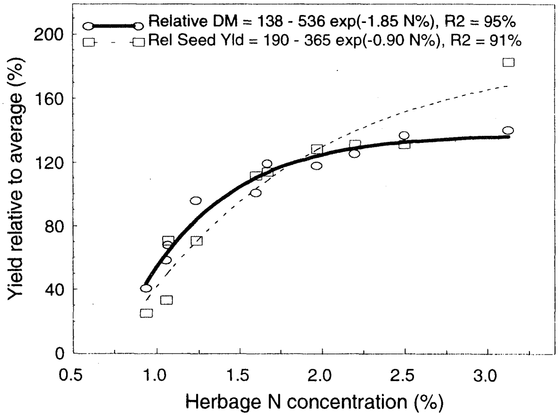

Figure 3. The effect of spring herbage nitrogen concentration (N%) on dry matter yield relative to the average, and seed yield relative to the average in *Lolium multiflorum*.

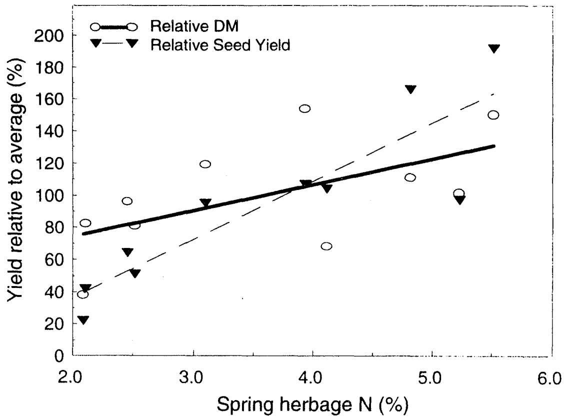

Figure 4. The effect of spring herbage nitrogen concentration (N%) on dry matter yield relative to the average, and seed yield relative to the average in *Lolium perenne*.

measured in this trial were twice that of the first trial, no suppression of seed yield was seen at high rates of N. In fact, there appeared to be a straight line relationship between increasing nitrogen and increasing seed yield; this is being investigated further.

Under field conditions, where water and weeds can be a major problems and harvesting is done mechanically, seed yields per plant would be lower than achieved in these experiments. However, the relationship between relative seed yields per plant and N status is not likely to be affected.

Discussion

The concept used in these experiments of looking at a plant characteristic, such as N status, and its effect on seed yield, rather than at the agent used to affect the plant characteristic, such as fertiliser, can be used in the field. For instance, there is considerable discussion about the best way to remove post-harvest residues from a long-term seed crop. Light into the base of the sward is considered important to stimulate tillering (Langer 1990), but what does burning or mowing,compared with doing nothing, do to the N status of the plant? Does the dead material left after doing nothing absorb more N (compared with burning or mowing the residue), thus depriving plants during what might be a critical period? By considering the effects on plant nutrition of the agronomic practices imposed by seed growers, researchers will be able to formulate guide lines that are general in their application, thus improving their efficiency.

References

Cornforth, I.S. 1984. Pasture analysis. *In:* Fertiliser recommendations for pastures and crops in New Zealand (eds. I.S. Cornforth and A.G. Sinclair), pp 34-36. Ministry of Agriculture and Fisheries, Private Bag, Wellington, New Zealand

Hampton, J.G., Clemence, T.G.A. and McCloy, B.L. 1983. Nitrogenstudies in *Lolium perenne* grown for seed. IV. Response of amenity types and influence of a growth regulator. *Grass and Forage Science* ***38***, 97-105

Hampton, J.G. 1987. Effect of nitrogen rate and time of application on seed yield in perennial ryegrass cv. Grasslands Nui. *New Zealand Journal of Experimental Agriculture* ***15***, 9-16

Langer, R.H.M. 1990. Pasture plants. *In:* Pastures: their ecology and management (ed. R.H.M. Langer), pp. 39-74. Oxford University Press, Melbourne.

Rowarth, J.S., Archie, W.J. and Baird, D.B. 1993. Nitrogen requirements for Italian ryegrass seed production. *In:* Plant nutrition - from genetic engineering to field practice (ed. N.J. Barrow), pp. 513-516. Kluwer Academic Publishers, Dordrecht.

Smith, G.S., Johnston, C.M. and Cornforth, I.S. 1983. Comparison of nutrient solutions for growth of plants in sand culture. *New Phytologist* ***94***, 537-548

Smith, G.S., Cornforth, I.S. and Henderson, H.V. 1985. Critical leaf concentrations for deficiencies of nitrogen, potassium, phosphorus, sulphur, and magnesium in perennial ryegrass. *New Phytologist* ***101***, 393-409

White, J. G.H. 1990. Herbage seed production. *In:* Pastures: their ecology and management (ed. R.H.M. Langer), pp. 370-408. Oxford University Press, Melbourne.