FERTILISERS FOR WHEAT

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INTRODUCTION

The question has been asked whether the local wheat crop can yield 10 tonnes of grain per hectare. In brief, the answer is "at least one local cultivar has potential for grain yield of 10 tonnes per hectare and has achieved this target on one occasion". In the 1975-76 season Karamu, without applied nitrogen yielded 10.6 tonnes per hectare and with 75 kg N/hectare yielded 11.3 tonnes/hectare in a field experiment on John Marshall's property near Methven. Clearly the question which should be asked is "why don't commercial wheat crops produce 10 tonnes of grain per hectare".

Grain yield in the local wheat crop is influenced by the climate, soil moisture, soil fertility, diseases, insect pests, weeds and possibly other factors not readily identified. Of these factors, diseases, insect pests and weeds are not a problem in every crop. On the other hand, all crops are affected by the climate, soil moisture and soil fertility. You cannot do anything about the climate, some of you can, if necessary, affect soil moisture but all can modify the fertility of the soil to favour high grain yield.

Grain yield in wheat is the final and nett expression of the processes of growth and reproduction and where these are adversely affected by any environmental factor effective grain yield is less than potential. In wheat, as in other crops, growth and reproduction require, among other things, an adequate supply of all essential nutrient elements and as a consequence grain yield is affected by the adequacy of the supply of plant nutrients. Apart from carbon, hydrogen and oxygen, the essential nutrient elements are obtained from the soil. Where the soil is unable to supply an adequate quantity, a state of deficiency exists. It is usual to correct an essential nutrient deficiency by applying an appropriate fertiliser. Application of fertiliser(s) incurs costs. If this practice is to be effective in the sense that grain yield is improved and efficient in the sense that a profit is made, both the nature and degree of deficiency must be established prior to the application of fertiliser(s). Where the soil can supply adequate quantities of the essential nutrients, application of fertiliser(s) is not necessary.

In this country, soils, commonly used for wheat production, have the capacity to supply adequate quantities of most essential nutrients. However, deficiencies of nitrogen and phosphate are common and important limitations to high grain yield in wheat. Deficiencies of potassium and manganese occur but are infrequent and limited to a few wheat soils. Deficiencies of other essential nutrients have, so far, not been associated with low grain yield in the New Zealand wheat crop.

NITROGEN

Nitrogen has a pervasive role in growth and reproduction

and even though nitrogen deficiency is more widespread than is generally appreciated "payable" responses in wheat grain yield to applied nitrogen are not general. These conclusions are based on results obtained from 222 field experiments carried out in northern Canterbury. In these experiments nitrogenous fertiliser applied at a rate of 75 kg N/ha caused a "payable" mean increase in grain yield of 1040 kg/ha on 21 percent of all test sites. On the other 79 percent applied nitrogen either depressed grain yield or had little positive effect. These data indicate that nitrogenous fertiliser has a place in the cultivation of the New Zealand wheat crop but that it should not be applied indiscriminately to all wheat crops.

Data from some of these experiments have been used to identify conditions which favour positive grain yield responses to applied nitrogen. Preliminary results suggest that in northern Canterbury positive grain yield responses to applied nitrogen are likely where -

* the soil concentration of nitrate nitrogen NO_3-N is low,

* the soil concentration of total carbon C is low,

* the ratio of arable crops to pasture in the preceeding five year period has been high,

* rainfall in August is high,

* rainfall in October is high,

* the soil concentration of plant available phosphate is high,

* a responsive cultivar has been sown.

The negative relationship between soil concentration of nitrate nitrogen and wheat grain yield response to applied nitrogen indicates a positive response is likely where the soil has inadequate reserves of plant available nitrogen. This bears out the earlier statement that fertilisers need to be applied only where a deficiency occurs. The concentration of nitrate-nitrogen in the soil may be established by soil analyses or inferred by consideration of cropping history and recent rainfall. Experience has shown that intensive arable cropping and heavy rains tend to deplete soil reserves of plant available nitrogen.

Likewise the negative correlation between soil concentration of total carbon and wheat grain yield response to applied nitrogen indicates positive responses are more likely where soil organic matter is low. This reflects the significance of "mature" organic matter as a source of plant available nitrogen.

The positive relationship between a high ratio of arable crops to grazed pasture, in the crop/pasture rotation, and wheat grain yield response to applied nitrogen is a measure of the depletive effects of arable cropping on the soil reserves of plant available nitrogen.

The positive correlation between rainfall in August and wheat grain yield response to applied nitrogen indicates positive responses are more likely when high rainfall is experienced. This is undoubtedly the consequence of the leaching of nitrate-nitrogen from the soil.

In the case of October rainfall the positive relationship

with wheat grain yield response to applied nitrogen arises from the wheat crop's need for adequate moisture throughout the period of moisture-sensitive growth and reproductive phases. In northern Canterbury both winter-sown and spring-sown wheat crops commonly experience severe drought as early as mid October, by which time in some years, shallow soils have reached wilting point. Thus there is a need for early irrigation in some years if positive grain yield responses to applied nitrogen are to be obtained.

The positive relationship between soil concentration of plant available phosphate and response to applied nitrogen indicates that the wheat crop must have available an adequate supply of phosphate if it is to respond positively to applied nitrogen.

The superior response in grain yield by some wheat cultivars to applied nitrogen reflects their capacity to make better use of the nutrient and indicates that if the most effective use of nitrogenous fertiliser is to be achieved, a responsive cultivar such as Kopara or Karamu must be sown. It is probable that the lack of response in wheat grain yield to applied nitrogen, reported in the 50's, was due, in part, to the lack of responsiveness in cultivars available at that time.

"Payable" grain yield responses in wheat to applied nitrogen are likely only where both the soil concentration of nitrate-nitrogen NO_3-N is low and soil moisture in the late spring/early summer is adequate. It is recommended therefore that where a responsive cultivar has been sown either in the late autumn/early winter or in the spring on a nitrogen deficient site, and where adequate soil moisture in the late spring early summer can be assured either

from rainfall or irrigation, that a nitrogenous fertiliser supplying up to 100 kg N/ha be applied in the early spring. For wheat established on nitrogen-deficient sites where late spring/early summer drought can not be offset, this recommendation requires qualification in so far that for late autumn/early winter-sown crops the maximum rate of applied nitrogen should not exceed 50 kg N/ha and that for spring-sown crops nitrogenous fertiliser be withheld. Also where the soil supply of nitrate-nitrogen is sufficient for crop growth and development, nitrogenous fertiliser should not be applied.

PHOSPHORUS

As in the case of nitrogen, phosphorus has a role in many processes of growth and reproduction in the wheat plant. Phosphate deficiency is a widespread and significant limitation to grain yield. "Payable" grain yield responses to applied phosphate are common. In 186 field experiments in northern Canterbury, "payable" grain yield responses to phosphatic fertiliser occurred on 73 percent of all test sites. At 23 kg P/ha applied phosphate caused a mean payable grain yield increase of 440 kg/ha.

A preliminary examination of data from some of these experiments indicates positive grain yield responses to applied phosphate are likely where -

* the soil concentration of plant available phosphate is low,

* little phosphatic fertiliser has been applied to preceeding pastures and arable crops,

* the ratio of arable crops to grazed pasture in the preceeding five year period has been high,

* soil moisture in the late spring/early summer is adequate,

* the soil concentration of plant available nitrogen is adequate.

Most wheat soils in New Zealand lack adequate supplies of plant available phosphate. Phosphate becomes available from the weathering of parent materials and accumulates from applications of phosphatic fertiliser. Where heavy and regular applications of phosphatic fertiliser have been made and not widely dispersed throughout a substantial volume of soil by cultivation, soil reserves of plant available phosphate may be ample for normal crop growth. The soil concentration of plant available phosphate can be checked by soil analysis.

Experience indicates that payable grain yield responses in wheat to applied phosphate are likely only where both the soil concentration of plant available phosphate is low and late spring/early summer soil moisture is adequate for continued crop growth. It is recommended that where a responsive wheat cultivar is to be drilled either in the late autumn/early winter or early spring, into a phosphate deficient soil, and where adequate soil moisture in the late spring and early summer can be assured that a phosphatic fertiliser supplying up to 25 kg P/ha be drilled with the wheat seed. Where late spring/early summer drought is experienced, the maximum rate of phosphatic fertiliser drilled with late autumn/early winter sown crops need not exceed 12.5 kg P/ha and in the case of spring-sown

crops phosphatic fertiliser may be withheld.

POTASSIUM

In northern Canterbury experiments, wheat drilled on sites which soil analyses had indicated had low concentrations of plant available potassium, gave few positive grain yield responses to potassic fertiliser. The current method used to assess concentrations of plant available potassium in the soil has, in the case of wheat, proved an unreliable indicator of potash deficiency. It is recommended therefore that, except where a "payable" grain yield response to applied potassium has been demonstrated, potassic fertiliser should not be supplied to the wheat crop.

MANGANESE

In Canterbury a manganese deficiency limiting growth of wheat has been demonstrated on some recent sandy soils. Its occurrence has been sporadic and in some cases affected crops have recovered spontaneously. It is recommended that where wheat shows manganese deficiency symptoms and responses to applied manganese have been conclusively demonstrated that affected crops be sprayed with a solution of manganese sulphate 25 kg/ha in water.

GENERAL

The wheat plant has a specific need for each essential nutrient element but this does not mean that fertilisers containing all nutrients have to be applied to all wheat crops. The kinds and quantities of fertilisers required if high grain yields are to be achieved, are only those

needed to correct soil nutrieht deficiencies and ensure an adequate supply. Field experience in northern Canterbury has shown that deficiencies of nitrogen and phosphate are common, that most wheat crops should be drilled with phosphatic fertiliser and where intensive arable cropping is practiced, nitrogenous fertiliser should be applied also.