IMPROVING WHEAT YIELDS : A REVIEW

B.L. McCloy

Farm Advisory Officer (Seeds)
Ministry of Agriculture and Fisheries
Christchurch

In this review I will sum up the various management options that are important in terms of wheat growing and put them together in what I call 'a management package'.

The management of the wheat crop will be considered under three headings:

* Establishment of the wheat crop

* Spring Management

* Harvesting and Storage.

ESTABLISHMENT

One of the major factors limiting yield is the below optimum number of heads per square metre and low head number is a result of either poor establishment or lack of tillering and tiller survival - or a combination of both. In order to obtain an optimum of 600 heads per square metre evidence suggests that we should be aiming for a plant establishment of 250 plants per square metre. This establishment phase is very critical if high yields are to be achieved.

Some of the factors affecting establishment are:

Germination

Germination is a measure of the seeds ability to produce a root and shoot under ideal or laboratory conditions. Few New Zealand wheats have a germination less than 90%.

Vigour

Different seed lines of the same variety can vary in rate of germination, seedling growth, and field emergence; this is known as seed vigour.

Under ideal conditions such as the laboratory germination test, differences in vigour between lines are not apparent, but when planted out in soil under stress conditions such as cold and wet soil, 'low' vigour lines will not emerge as well as 'high' vigour lines. Under non-stress conditions the germination test relates well to field emergence.

However, a vigour test would be an advantage to differentiate lines of low vigour which would be expected to have poor emergence under stress conditions. As yet no reliable vigour test is available but research work presently underway at the Seed Testing Station in Palmerston North has identified some promising test methods. Further field work will be required before a vigour test can be offered.

Seed Size

Seed size can be regarded as a component of vigour. It becomes one of the important criteria for working out sowing rates. Seed size is now measured as the weight of 1,000 seeds. There are large differences between lines and within varieties. In the 1979 sowing season the

average 1,000 seed weight for Kopara was 41 g per 1,000 seeds, but the range was from as low as 36 g to as high as 52 g. The 1,000 seed weight is now included on Purity and Germination certificates for all cereal lines.

Seed Health

The use and correct application of a broad spectrum seed treatment will ensure that emergence failures due to seed or soil borne diseases are not common.

Seed-Bed

Ideally we should be aiming for a good clean, moist seed-bed which is not too fine nor too cloddy. The seed-bed should be free of crop residues and other grass volunteers that could act as potential disease sources.

Time of Sowing

In lack of suitable research evidence, but based on adviser and farmer experiences the optimum time for autumn sown wheat is early May. This will allow effective root growth and a well developed seedling prior to winter. A well developed root system will help alleviate a potential moisture stress in late spring to summer.

Early sowings will require protection against late flights of cereal aphid (BYDV problem) either by application of an insecticide down the spout at drilling or by spraying with a suitable insecticide sometime between the end of June and the end of August.

It could be included as a tank-mix with a suitable herbicide or fungicide application in August.

Sowing Method

The drilling depth should not exceed 5 cm, the optimum being 2-3 cm in a good seed-bed.

The drilling speed should not exceed 7 km per hr and so maintain an even distribution of seed down the row. Work in the United Kingdom has shown that the highest yields usually come from precision drilled crops. Although this is not a common practice it does highlight the importance of seed placement, the depth of sowing and the slow speed at which the operation is carried out.

Sowing Rate

Traditionally autumn wheat has been sown at 100-130 kg per ha with no account taken of seed size and therefore no account of the possible number of plants that will establish per square metre.

After several years of trial work, at Lincoln, Dougherty and Scott showed that optimum yields were obtained from sowing rates which gave 250 plants per square metre.

Increases in sowing rate that give above the optimum number of plants established result in yield depressions, due to a decrease in the number of grains per spikelet, and this is not entirely compensated for by higher head population.

When working out sowing rates we must know the 1,000 seed weight of the line, and the expected field emergence (EFE) of the line. For autumn sown wheat in Canterbury recent research work has shown an E.F.E. of 70% to be realistic. See tables 1 and 2.

TABLE 1. SOWING RATE AND ITS EFFECT ON PLANT NUMBER

Sowing Rate	*120 kg/ha*	
1,000 seed wt (gms)	35	45
No seeds/m^2	340	265
No plants/m^2 at 70% E.F.E.	240	185

TABLE 2. SOW BY SEED NUMBER

Desired plant population/m^2		*250*	
At 70% E.F.E. seeds/m^2		360	
1,000 seed wt gm	35	40	45
Sowing rate kg/ha	126	144	162

SPRING MANAGEMENT OF THE WHEAT CROP

Before I review the various aspects of the crop husbandries I think it is important that we are familiar with the Growth Stages of the wheat crop. See figure 1 on next page. It is important to time our management practices to suit the stages of growth the plant is at and not by calendar dates.

Use of Nitrogen Fertilizer

Nitrogen fertilizer is one of the most powerful management tools that we have available for manipulating crop yields. Mis-used or badly timed nitrogen applications can cause yield reductions, but if the right amount is applied at the

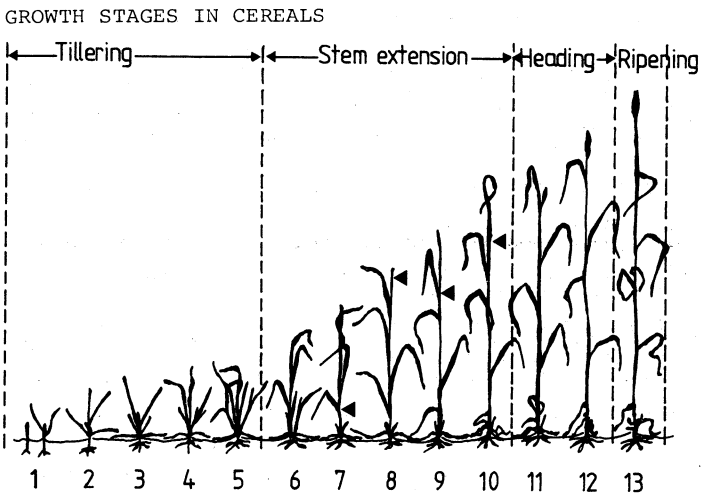

FIG. 1. FEEKES GROWTH STAGES IN CEREALS

right time it can have a very beneficial effect on yield.

The timing and amount of nitrogen applied are operations which the farmer does have some control over. The reason for applying nitrogen is to either increase tillering or increase the tiller survival rate, so as to make sure we harvest the optimum number of heads.

Under New Zealand conditions there are two critical growth stages at which the application of nitrogen may increase yield. The first is at GS2 to stimulate tillering. The second at GS5 or spikelet initiation to increase the tiller survival rate; it may also have a small positive effect on the number of grains per head. Under New Zealand conditions late applications of nitrogen - after GS7 - will not give yield increases but may have an effect on the protein level.

We should be aiming to establish 250 plants per square metre and I consider that the timing of our nitrogen application should hinge around the number of plants that have established.

If our plant populations are below this number we should apply nitrogen at GS2 to stimulate tillering.

If above 250 we should hold back our nitrogen application until GS5 because we only require the main shoot plus one or two tillers to give us our optimum head number.

The amount of nitrogen applied to the crop should be governed by the amount of leaching that has occurred during the winter months, the previous cropping history of the paddock, and the ability of the soil type to withstand these populations. We must take note of the amount of soil moisture that will be available later in the season either from the soil profile or from irrigation.

Disease Control

Disease control now plays a very important part in our management package for increasing and maintaining higher yields. See other papers in this review of wheat production regarding diseases such as take-all, mildew and rust.

Let me comment briefly on some aspects.

Speckled leaf blotch must be controlled early in the growth cycle of the wheat plant. If not controlled it can cause yield loss through reduction in the number of grains per head and secondary infestations on the flag leaf causes reductions in the individual seed weight. Therefore if the disease is present it must be controlled in early spring - say mid August. If eyespot is detected in the crop at

GS7 it must be controlled.

The most important part of any disease control policy must be the regular inspection of the crop for disease outbreaks. If mildew or rust are detected and starting to build-up, especially on the upper leaves some action must be taken against them. This will usually mean spraying with one of the new systemic fungicides between GS10-10.5.

There is no point in spending time and money on growing a good crop, if we are not going to pay attention to the effects the disease can have on our potential yields.

Weed Control

On most cropping farms, weed control tends to be a 'as is when is necessary' type of application. I see no reason why this approach should change provided we are aware of the various weed problems.

Different farms will have different weed spectrums, and therefore require different management practices and chemicals to control them.

Pest Control

Like weed control, pest control also tends to be a 'as is when is necessary' type of application.

Most insects can be controlled by the application of a suitable insecticide either at establishment or at a stage when the pests are likely to become a potential problem.

Irrigation

Earlier comment in this review suggests that for winter

wheat on the light soil, one irrigation when the soil moisture level reaches 10% gives the best yield response, this usually occurs about GS10 or booting stage. For spring sown crops under good fertility conditions, or where nitrogen has been applied at drilling to poorer fertility crops, irrigating at the 10% soil moisture gave excellent returns in most years. This usually required two irrigations, one at GS10 and again at GS11 or milk ripe stage. Where nitrogen was applied at the tillering stage the yield response to irrigation were increased.

On these lighter soils the yield responses were mainly due to increases in grain weight from a very small grain with a 1,000 seed weight of 32 gm to a 1,000 seed weight of 44 gms.

All of this irrigation research work has been undertaken on the lighter Lismore soil type which represents only a very small fraction of the wheat growing area.

On the medium to heavy soil types limited research work has shown that the response to irrigation is a result in an improvement in tiller survival, and that spring sown crops are generally more responsive than winter sown crops to irrigation because they are more susceptible to moisture stress.

If irrigation is available on the medium and heavy soil types it should be used whenever a moisture stress is likely to occur, especially during the floret growth and grain filling stages.

Use of Straw Shorteners

The direct effect of a straw shortener, as the name suggests, is to cause a reduction in stem length and slightly increase

the diameter of the stem. The nett effect is to increase straw strength and allow better root development. This does not result in any large increases in yield but does allow us to use higher rates of other inputs, especially nitrogen, which if applied at the right time can result in beneficial yield increases. The straw shorteners should be applied at the beginning of GS6 or stem elongation stage.

HARVESTING AND STORAGE

The main objective of any harvesting operation is to safely gather and store all the grain that we have paid so much attention to producing.

This involves correct timing for harvesting and correct combine settings.

If the grain is to be artificially dried make sure you are familiar with the techniques of grain drying.

Also ensure that the silos are clean and free of insects and vermin. Remember that a 60 tonne silo full of grain is like having $10,000 in cash in one pile!

SUMMARY

In summary I quote a paragraph from an article entitled Cereal Growing, Past, Present and Future.

> "ATTITUDE TOWARDS THE CROP
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> "One of the principal themes of the modern approach to cereal growing has been to emphasise the need for attention to detail. Again, this is not new.
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> "In 1771 Henry indicated a considerable respect for the physiology of the wheat plant when he commented:

'When the season of tillering is past, no culture will make the plant throw out more branches, and after the ear has shot, it is impractical to make it larger. After the time of blooming, there is no adding one grain more than is already formed in the ear'.

"This is all sound observation, but now we are advocating that farmers fully understand the growth stages of the cereal plant, so Henry's final comments are even more remarkable: 'It is therefore of importance for us, to know the periods of growth of the different parts of the plant: and that if we happen to miss assisting it at one time we may improve it at another'.

"However, the embarrassment does not stop there. In 1577 Barnaby Googe stated that: 'The best dung for ground, is the masters foot'; which must be the 400 year old precursor to our present advice, to regularly inspect your crops.

"Statements such as this, made 200 years ago, cause one to wonder exactly what we have achieved since that date."