Controlled Traffic and Split Fertilizer Application in Dryland Farming

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Background

Controlled traffic is a system where machinery movement is restricted to a set of wheeltracks on which all machinery runs. It has been shown that unwheeled soil produces higher yielding crops while permanent wheeltracks facilitate more timely machinery operations and reduced fuel costs (Tullberg 1995). Controlled traffic is one aspect of conservation farming.

Controlled traffic facilitates split application of fertilizer in a crop in that fertiliser can be applied later in crop growth, rather than all at or before planting, with minimal damage to the crop. Strong (1981) found that for irrigated wheat on the Darling Downs less than half of the N available at planting was converted into grain and concluded that this low (and variable) assimilation rate made fertilizer applications at planting an unattractive strategy for ensuring high protein wheat.

Subsequent research by Strong (1986) found that the same amount of N applied before planting or as equal amounts at planting and tillering (or at planting, tillering and boot stages) produced similar grain yields. Thus N could be profitably applied up to the boot stage. Split applications of fertilizer at tillering and boot stages increase grain protein only marginally usually by less than 1% but later applications (flowering onwards) can cause large increases which may give an economic return (Strong and French 1998). Strong (1986) suggests that N application after sowing could be a useful option for both dryland and irrigated crops because it allows additional N to be applied when crop needs are more easily assessed and when its utilization by the crop is more assured.

The split application rate will be highly dependent upon such factors as moisture levels in the soil profile, SOI levels and expected rainfall probabilities and thus the yield and/or protein improvement expected relative to the cost of applied fertilizer. Strong and French (1998) recommend that the crop's yield potential and anticipated nitrogen supply from the soil be determined and any other factors such as waterlogging, disease, weeds or other nutrient deficiencies be taken into account in determining the fertilizer rate and timing of application.

Split application of fertilizer in a controlled traffic system has several advantages for crop management especially for dryland farming. Growers may delay their decisions on fertilizer rates by applying a low rate of fertilizer at or before planting and then deciding on the final rate to be applied later in crop growth taking into account the seasonal conditions. In a poor season, no further fertilizer may be applied with a subsequent saving in cost. In contrast, in a good season, there may be considerable yield and/or protein benefit from a split application. Hence split fertilizer application offers growers more flexibility in crop management.

The decision support package, WHEATMAN, provides information on the performance of the cultivar, Hartog, sown on June 1 with 150 mm of available water for a 'good season' and 80, 130 and 180 kg/ha of available N at planting (Table 1).

Table 1. WHEATMAN output (after Strong and French 1998)

	No N top-dressing		Top-dressed 50 kg/ha N		Increase due to top-dressing	
Available N kg/ha sowing	Grain yield (t/ha)	Grain protein (%)	Grain yield (t/ha)	Grain protein (%)	Grain yield (t/ha)	Grain protein (%)
80	3.0	9.7	3.3	12.3	0.3	2.6
130	3.7	11.4	4.3	12.5	0.6	1.1
180	3.9	12.4	4.7	12.7	0.8	0.3

These results suggest that the yield improvement is relatively higher if there was 130 kg/ha or more of N available at planting but the improvement in grain protein was relatively small (grain protein increase inversely related to yield increase). The crop needs to be growing well without any check to its growth for significant yield improvement to occur from split application. These figures suggest that top-dressing this cultivar with 50 kg/ha of N would not produce the prime hard grade protein content of 13%.

Assuming urea costs $406.70/t, the cost of 50 kg/ha N as urea would be $44.21. If application costs $6/ha and AH quality wheat receives $138/t, then for 80, 130 and 180 kg/ha N available at sowing and top-dressing with 50 kg/ha N, the expected increase in returns from top-dressing with 50 kg/ha N would be -$8.81, +$32.59 and +$60.19 respectively. If growers can produce prime hard quality, then a premium of $22/t would be available; this may be sufficient incentive for a late application (flowering) of fertilizer.

Using controlled traffic, a ground rig should be able to traverse a crop with minimal damage provided there is a guidance system to keep the tractor on the wheeltracks and there is sufficient clearance. Because it is possible to get on the ground earlier with a controlled traffic system than for a conventional system, fertilizer can be applied to moist soil. This has several advantages over aerial application:

- some fertilizer will be immediately available as it will dissolve quickly; thus the need for subsequent rain increase fertilizer availability is reduced. This should result in an assured response in the crop.

- fertilizer is less likely to be lost through volatilisation or by leaching, thus reducing the rate which needs to be applied

- no leaf burn because fertilizer does not come in contact with the foliage

- lower costs due to lower application costs and reduced fertilizer rates

Drilling of fertilizer into dry soil may be necessary in some seasons but is heavily reliant on subsequent rain to make it available. All but the first advantage listed above would still be gained. Of course, it would be possible to broadcast fertilizer using a controlled traffic system. However, several of the advantages listed above would be lost.

Trial Methodology

A wheat trial was planted on 3 m beds on June 11 at Gatton College with the following aims:

- to compare drilling fertilizer with broadcast application to determine whether drilling adversely affects the crop at late tillering and flowering; possible adverse effects include loss of plants, pruning of the root system and damage to stems and ears

- to compare fertilizer applications at sowing with split applications at late tillering and flowering on dry matter accumulation, grain yield and protein

Prior to seeding a basal dressing of 30 kg N/ha was drilled in all plots with an additional 70 kg N/ha being applied to four plots. The nitrogen was applied as ammonium sulphate (Granam) as the site was shown to be deficient in sulphur as well as nitrogen (the preceding crop was grain sorghum).

Eight weeks after planting, a further 70 kg/ha of N was drilled or broadcast on the plots. Drilling appeared to have minimal effect on the crop. A light irrigation was applied after the fertilization. A further 30 kg N/ha will be applied at flowering (both drilled and broadcast) to study the effect on yield and yield components as well as damage to the crop.

Conclusions

There are good theoretical reasons to suggest that applying nitrogen fertilizer as a split application will increase yield, protein and fertilizer use efficiency.

The current trial will supply further information on these aspects. This trial has demonstrated that it is possible, using controlled traffic technology, to drill fertilizer between rows 25 cm apart eight weeks after planting without any apparent adverse effect on the crop.

This system offers exciting possibilities for wheat, barley, sorghum, millet and other crops which are capable of being traversed by a modified fertilizer applicator late in crop growth. For some crops, the system may not be feasible late in crop growth because of physical limitations of height and canopy spread. Row spacing in winter cereal crops may be increased to allow more rapid drilling of fertilizer in a split application; however, a guidance system may overcome this limitation. More research is also needed to investigate the effects of timing of split applications on dryland crops.

References

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