Relay Cropping and Controlled Traffic: Preliminary Results

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Introduction

Relay cropping as practiced in developing countries involves the planting of a second crop before harvest of the first crop occurs. This traditional system of farming is efficient in the utilisation of resources such as water, nutrients and light and may result in greater output of produce per hectare per year. In addition, crop cover is maintained for a longer time period thus minimising evaporation, runoff and soil erosion.

In developing countries, manual labour is most commonly been used to produce crops under relay cropping systems. This is not an option in developed countries due to high labour costs. A mechanised system using controlled traffic can facilitate relay cropping in several ways:

- passage of planting and harvesting machinery through a standing crop with no or minimal damage to it
- a guidance system that keeps machinery on the same wheeltracks thus limiting wheel track effects to non crop zones

For this system to be successful, all machinery needs to have the same width wheeltrack, preferably as wide as possible to minimise land area lost from production. The issue of matching harvester wheeltracks to that of the planting equipment needs to be addressed. Planting equipment may need to have higher clearance than conventional planters to avoid damage to developing grain heads especially late in development when stems are less flexible. Other crop injury could arise from root damage to the first crop when planting the relay crop.

For dryland farming in northern Australia, this strategy would be highly dependent on stored moisture sufficient to produce an economic yield, timely planting rains, pest and disease pressure and crop options. However, even under drought condition, Durrand (1995) found that in some cases intercrops outperformed sole crops.

Relay cropping may not be possible every year but could be undertaken when the opportunity arises. It does allow growers to sow earlier than if they waited until the first crop was harvested, or even to sow at all, if no subsequent planting rains are received. Earlier planting reduces potential moisture loss to weeds and evaporation. If earlier planting results in earlier maturity, then it may be possible to plant a second crop in the same season. In addition, relay cropping may enable sowing to occur closer to the planting time which optimises yield for that crop.

Relay cropping of winter crop into a summer crop is not likely to be as viable as relay cropping of summer crop into a winter crop due to:

- the need for stored moisture from the predominant summer rains; this stored moisture will be depleted by the summer crop
- most summer crops are harvested earlier than the optimum planting time for many winter crops

Some crop options may not be available due to the physical nature of the first crop. For example, it would be difficult to plant into a chickpea or faba bean crop due to the spread of the canopy. Harvesting of these crops without damage to the relay crop would be also difficult due to pod development throughout the crop. It would be difficult to plant into a tall crop such as maize due to height limitations of the planting machinery. Other issues that need to be addressed include row spacing, fertilisation and weed control.

Wider rows may be needed to facilitate planting of the second crop. Slightly wider rows should not reduce yield significantly. Guidance systems which allow planting machinery to stay on track will be essential for precise placement of rows between those of the first crop and may reduce the need to increase row spacing greatly in the first crop.

Fertiliser may be needed for many of the second crops and can be applied before and/or at planting. Fertiliser will need to placed such that seed germination is not affected. Ideally, fertilisation and seeding could be done simultaneously. Split application of fertiliser may be applied after harvest of the first crop.

Weed control could prove to be one of the most challenging issues for relay cropping systems. It is likel that as the first crop reaches physiological maturity and starts leaf senescence, then more light will penetrate to the soil surface where it will stimulate germination of weed seeds. Selective herbicides will be needed to control these weeds to enable establishment and growth of the second crop. Lack of selective herbicides may result in relay cropping being practiced on relatively weed-free country. For herbicides applied prior to physiological maturity of the first crop, these will need to be safe for that crop. Residual activity of herbicides applied to earlier planted crops will be an important consideration in the choice of second crop.

Methodology

Wheat (cv. Hartog) was planted with a JD 4040 (3 m wheeltracks) and John Shearer planter at the University of Queensland, Gatton College on June 3 1997 in a controlled traffic system. A row spacing of 35 cm which is wider than for a normal crop was used to facilitate intercropping.

Sorghum was planted at a row spacing of 35cm at two dates during the development of the wheat crop. These were:

- one week prior to physiological maturity (2/9/97)
- two weeks after physiological maturity (28/9/97)

A third planting date, four weeks post harvest (1/12/97) was used for sorghum and sunflower. This was done to (1) allow comparsion of the two crops under a stubble canopy, and (2) assess the gains associated with an intercropped versus double cropped strategy.

Sorghum was planted using a hand planter due to difficulties in developing a specially modified tractor and planter in time.

For the sole sorghum treatment, wheat was cut and left on the plots; sorghum was planted into these plots. Thus these plots had the same history as the intercropped plots prior to sowing. This treatment was required so that sorghum planted alone could be compared with intercropped sorghum.

Data was collected on moisture usage, light interception, weed density and yield of first and second crops.

Results

Sorghum seed failed to germinate in the first sowing and germination was poor for the second sowing date for the intercropped treatments, even though germination and establishment were successful in the sole sorghum plots . This was most likely due to low soil temperatures under the wheat canopy (Figure 1). Minimum temperatures experienced by the intercrop were consistently lower by 1 – 2 degrees C than that of the sole crop. Temperatures frequently fell below 15 C, the minimum temperature required for sorghum germination.

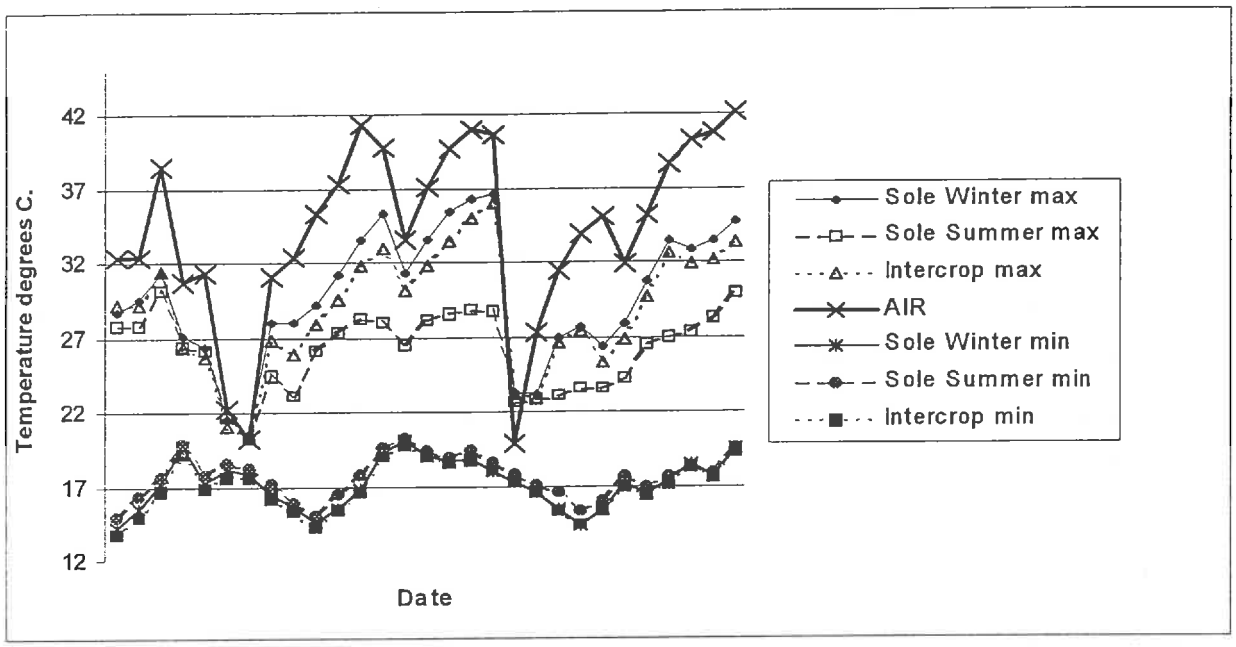

Figure 1. Daily maximum and minimum soil temperatures

Further investigation into the effect of rainfall and overcast conditions on the soil temperature beneath the canopy will be undertaken in this seasons trial.

Monetary Returns

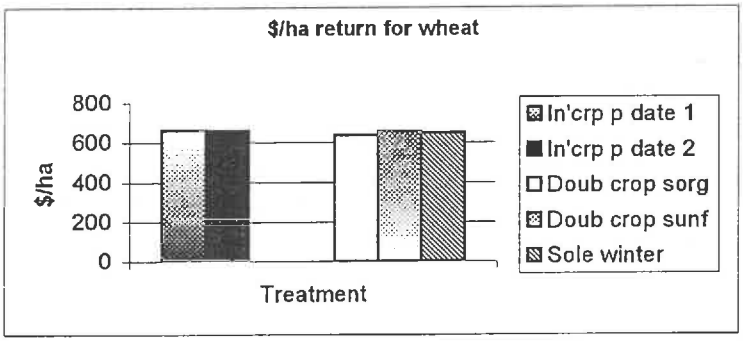

Figure 2 Yield of Wheat only

The crop yield was expressed in terms of dollars per hectare with Figure 2 showing that planting the sorghum into the wheat crop had no negative effect on the wheat yield.

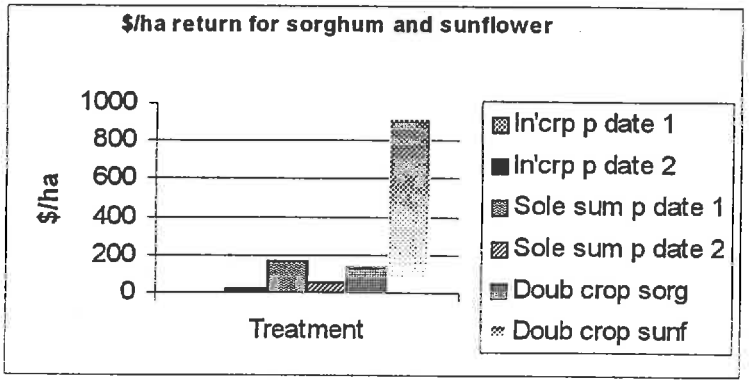

Figure 3. Yield of summer options only

Sunflowers yielded more in the double crop system. In this season's trial, it will be used as the preferred summer option because of its lower temperature requirement for germination (8 – 10 degrees C).

Yield data showed no adverse effects on wheat yield due to the intercropped sorghum from the second sorghum planting onwards (the first planting failed to establish). The wheat was harvested with a tractor mounted stripper harvester with some adverse effect on the young sorghum plants of the second sowing date. This was due to the similarity in height of wheat heads and sorghum leaves.

Weeds became an increasing problem as the wheat crop matured, particularly in the final planting date due to the four week period between harvest and sowing. Unfortunately the method used to score weed pressure was not accurate enough to relate crop yield to weed pressure. This has been altered to improve the measuring precision. It was found that plant height did relate to weed pressure with higher plants having a lower weed burden. Measurement of plant height has also been reviewed and both weed pressure and crop height will be monitored for this seasons crop.

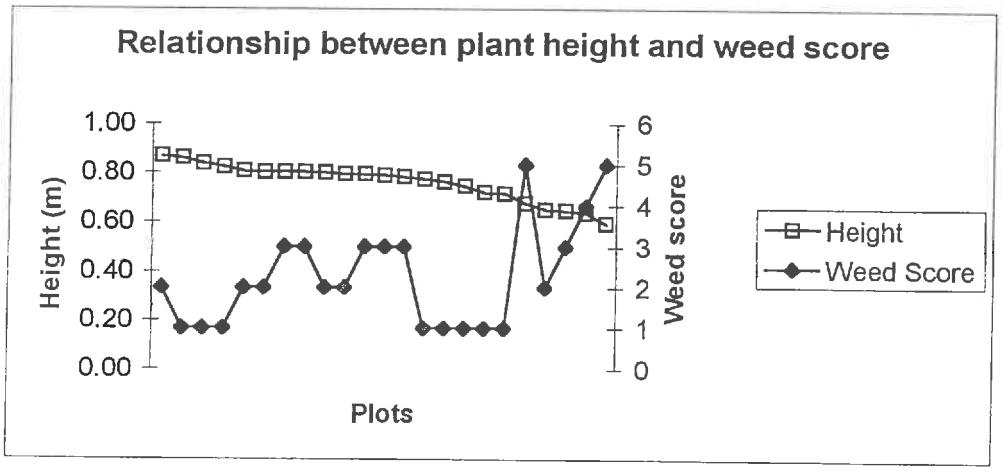

Figure 4. Weed score information

Conclusions

Preliminary results indicate that relay cropping of a summer crop into a winter cereal crop is possible and may be a useful strategy in the northern grain belt. There is a high probability of spring rains in October - November when the wheat crop is physiologically mature but awaiting drydown to moisture content safe for storage. Given sufficient moisture stored in the soil profile and a planting rain, it is feasible to plant sunflower, millet, sorghum or a legume crop as a relay crop. Thus these crops may be planted up to five to six weeks earlier than would be the case without relay cropping.

Lower soil temperatures due to canopy cover of the first crop may pose a limitation to some crops such as sorghum which requires a minimum temperature of between 15 and 18 degrees for germination. In this trial the planting date (2 weeks after physiological maturity) used for sorghum was too early as plants reached a similar height to wheat. This meant sorghum was damaged when the wheat was harvested. Sorghum grown under the wheat canopy, compared to bare plantings, seemed to be more erect as a result of light competition with the wheat. Later planting dates will be trialed in this season and sunflowers, with their planophile leaves, should cope better in the shaded environment.

To overcome soil temperature limitations sorghum may be relayed into an early maturing crop of mung bean or millet in a late summer planting. Before this is attempted,the risk of midge infestation should be assessed.

Weeds were a major consideration in the late sorghum plantings and have highlighted shortcomings of the method in the pilot trial. These have been altered and further research will occur.

References

Durrand, J.L. (1995) Response of morphogenesis to water deficits and competition. In: Sinoquet, H., Cruz, P. (eds) Ecophysiology of Tropical Intercropping, (INRA: Paris).