Performance of simulated dryland skip-row cotton

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SUMMARY

Crop simulation is an extremely useful research and management tool. Assessments of many management options can be evaluated with long term weather data to assist with refinement of cropping systems to optimise profit.

Recent research has improved the prediction of water extraction of dryland skip row cotton — this further improves our ability to do strategic analyses and recommend less risky and more profitable management strategies.

The OZCOT crop simulation model (initially developed by Brian Hearn of CSIRO Plant Industry in 1994) is a management and research tool that can be used to assess the performance of cotton crops under different environmental and management conditions. Importantly the performance of cotton crops can be predicted from long-term weather data and we can learn from successes and mistakes of implementing actions without the effort and cost of real-life experiments.

The OZCOT model is a critical component of the HydroLOGIC irrigation management decision tool. It is also currently being used successfully for assisting with dryland cropping production decision making as part of the FARMSCAPE and Whopper Cropper initiatives led by APSRU out of Toowoomba. This article outlines efforts to improve and test the ability of OZCOT in dryland cotton systems, especially when cotton is grown in different skip-row configurations.

The intention behind skip row configurations is to provide slowly available soil water to the planted rows to allow continued growth during dry periods. In practice, however, the benefits lie primarily in:

- A reduced risk of negative effects of water stress on fibre quality;
- Reduced yield variability; and,
- Better economic returns due to production costs being reduced more than the yield relative to solid planted cotton.

OZCOT was modified to allow for the possibility that water in the skip is not as freely available as the water in the plant row. Including these modifications to allow for differences in soil water extraction significantly improved predictions of crop yield for cotton in skip row configurations across a number of locations in the eastern Australian cotton producing regions.

The model's simulation of skip row yields when compared to solid planted crops grown under the same conditions reflected the relationships seen in the measured data and those published in other industry literature. These improvements should help the accuracy of predictions of yield when information generated from OZCOT is used to assist with complex decisions relating to the choice of row configuration in dryland cotton systems.

METHODS TO IMPROVE OZCOT FOR SKIP-ROW

Research on the Darling Downs has measured the extraction patterns of dryland cotton under different row configurations. The results showed that in both double and single skip row configurations, the crops had water available for a longer time and during critical stages of growth.

They also indicated that moisture at all positions across the skip could be depleted to the lower limit of plant available water holding capacity. Similar results have also been found for a range of soil types in northern NSW.

The results showed the water under the plant line was more readily available and was extracted first. Water extraction then proceeded across into the skip. In other words, water in the skip is not as freely available at the start of a drying cycle compared with water under the plant line.

Based on these results, the OZCOT model was modified to extract water from under the plant row until water supply limits crop transpiration. When supply from the plant row becomes limiting, water is drawn from the skip at the limited rate until it is depleted to the same level as the plant row, after which water is drawn from the plant row and skip simultaneously.

For validation purposes, yield and agronomic management data were compiled for a number of previous experiments (Table 1). The experiments were conducted in northern New South Wales and southern and central Queensland.

TABLE 1: Details of data collated to validate the OZCOT cotton simulation model for different row configurations — all experiments included solid, single and double skip row configurations

Source	Location	Year	Varieties	Water Supply
Pyke (1991) Central Queensland	Biloela Vandeena Mt Wilkins	1991–92	Siokra L22, DP90 Sicala V–1, Siokra S324	Dryland Partial irrigation Full irrigation
Gibb (1995)	Boggabilla	1994–95	DP90	Partial irrigation
Hearn (unpublished)	Australian Cotton Research Institute (Narrabri)	1988–89 1989–90	DP90 Siokra 1–4	Dryland Partial irrigation Full irrigation
Goyne (2000) Darling Downs	Perrinuan Hermitage Research Station Warwick	1995–97	Siokra L22, CS8S Sicot 189, Siokra S–101, Siokra V–15	Dryland

Configurations tested were solid plant, single skip and double skip.

Except where noted, all configurations were tested at each site, and where there was more than one year, variety or water supply at one site, all factorial combinations with each configuration were applied. There were 100 treatments in all, made up of 34 solid plant, 34 single skip and 32 double skip treatments.

The graphs presented in Figure 1 are a visual means of comparing how close the predicted yield compares with the measured yield. In these comparisons, the closer points are clustered around the 1:1 line drawn on the graphs, the better the predictions made by OZCOT. The 1:1 line is the position on the graphs where the simulated yield equals the predicted yield.

OZCOT PERFORMANCE PRIOR TO MODIFICATION

Prior to modification, OZCOT simulated the solid planted treatments in the data sets reasonably well. OZCOT was less reliable

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FIGURE 1: Calibration stage — predicted lint yield versus observed lint yield for all data, solid, single, and double skip configurations individually prior to modification of the model

Solid line is the line of best fit.
Dotted line is the 1:1 line.
Thumbs up signifies improvement in predictive capability of the OZCOT model

FIGURE 2: Validation stage — simulated lint yield (bales/ha) versus observed lint yield for commercial rain-fed cotton crops with various row configurations grown in southern Queensland and northern New South Wales

Also shown is the 1:1 line. (R^2 = 0.70).

FIGURE 3: Comparison of predicted yields using the modified OZCOT model for skip row versus solid planted crops from experiments used in this study where both configurations were measured

Solid lines (closed circles) are the regressions for single skip versus solid configurations. Broken lines (open circles) are the regression for the double skip.

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for the simulation of the skip-row treatments (Figure 1). There was more dispersion than for the simulation of solid plant treatments. The lines of best fit showed positive intercepts and slopes less than 1.0, indicating a bias to overestimate yields at the lower end of the range.

EFFECT OF MODIFICATIONS TO OZCOT FOR THE SIMULATION OF SKIP ROW

Including the modification of OZCOT to allow for the differences in accessibility of soil water in the skip and in the row improved the overall reliability of the predictions (Figure 1). Importantly the modification did not modify the performance of the model for the solid configuration.

PERFORMANCE OF OZCOT TO SIMULATE ON-FARM CROP YIELDS

A number of dryland crops (all configurations) were grown across southern Queensland and northern New South Wales cotton production areas. Lint yields of these crops were compared with those estimated by the OZCOT simulation model. This process allowed growers to gain experience in the ability to use simulation technology as a tool to explore crop management issues.

These tests confirmed that OZCOT simulated commercial rain-fed cotton production (Figure 2). For most crops where simulations were considerably different from the measured lint yields, we have been able to determine the reasons for the discrepancies — most were due the impact of factors not accounted for in OZCOT (for example severe pest damage).

DISCUSSION

Modifying OZCOT to allow for differences in soil water extraction significantly improved predictions of crop yield for cotton in dryland skip row configurations across a number of locations in cotton producing regions. The performance was within the range of results published by Brian Hearn for solid planted crops over a range of nitrogen and irrigation treatments and planting dates. These relationships can be used to determine the change in potential yield when compared with solid when considering skip row configurations (Figure 3).

While OZCOT can be used successfully to predict yields in commercial dryland production, there were a number of general limitations to the use of OZCOT to address questions relating to row configuration. One of the important considerations in the choice of configuration is the trade-off between yield potential on the one hand and variability in yield and fibre quality on the other. While skip row configurations have lower yield potential they are widely used because of reduced growing costs and less risk of low fibre quality in years when rainfall is low.

OZCOT is being enhanced to encompass the effects of environment on fibre quality and is currently being tested before being made widely available. This will add significant value to using the model to choose row configuration in rain-fed cotton systems.

Another issue is the potential differences in nutrient uptake associated with skip row configurations. This is further complicated by skip row systems that vary the placement of fertiliser. There is currently no published information on this area. These aspects are subjects of continuing research.

Information for crop management decisions that has been generated from the latest version of the OZCOT model can also be found in the Australian Dryland Cotton Production Guide.

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