Are there pre-sowing indicators for choosing in which seasons to companion-crop wheat into existing lucerne ?

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Abstract

Companion-cropping cereals into perennial pastures has been widely considered as an option for reducing recharge and improving the sustainability of farming operations in the Australian wheat belt. Indiscriminate annual sowing of wheat into existing lucerne is shown to be a high-risk management strategy, with long-term average wheat yield penalties (compared with a wheat monoculture) of up to 60%. In addition to years when companion-cropped wheat performs poorly, there are a certain proportion of years when companion wheat yields are comparable to monoculture wheat yields. A modelling investigation using APSIM was conducted on a large range of pre-sowing variables, specifically looking at their indicative value for wheat companion-cropping success in the following season, for two agro-climatic zones in southern Australia. Three early-season variables were shown to be particularly correlated with subsequent companion-cropped wheat success – available soil water at sowing, timeliness of the sowing opportunity, and April-May Southern Oscillation Index (SOI) phase. The value of each of these indicators varied considerably between the two sites.

Key Words

Lucerne, wheat, companion-cropping, APSIM

Introduction

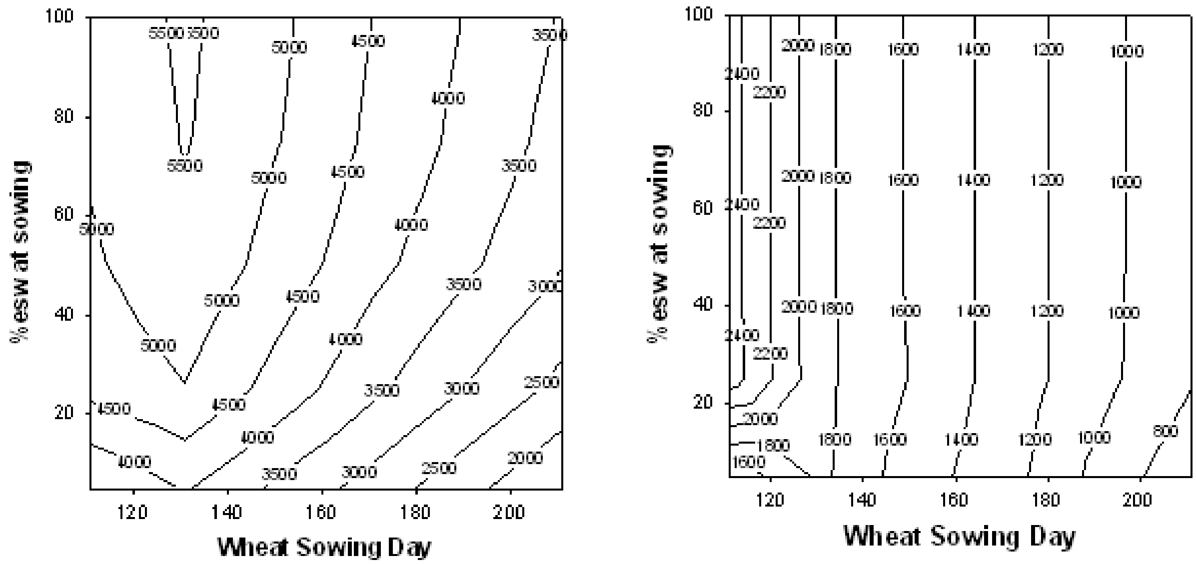
The introduction of deep-rooted perennial crops such as lucerne into annual cropping systems can play a valuable role in reducing salinity risk by increasing water use. Latta. *et al* (2002) found that 2 to 3 years of lucerne can provide an effective soil water recharge buffer, allowing 3-4 years of subsequent annual cropping without significant recharge. However, Ridley *et al.*(2001) found that the soil water buffer can disappear in 1 year in seasons with high spring rainfall. To protect against high rainfall season risk, a system in which annual crops are sown directly into existing lucerne (companion cropping) may provide advantages over traditional lucerne-wheat phase farming. Robertson *et al* (2004) demonstrated an ability to simulate the performance of companion-cropped systems using APSIM. This paper presents details of a subsequent modelling investigation into pre-wheat-sowing system variables, and their value as predictors of subsequent intercropped wheat success, for two locations in the Australian wheat belt.

Methods

APSIM v3.6 was configured for two sites: Corowa (Vic) and Katanning (WA), and simulations were performed over the period 1957-2003. At each site, lucerne (*Medicago sativa* cv. Sceptre) was sown in 1957 and remained in the simulation until the end at a density of 250 stems/m^2. Wheat (*Triticum aestivum* cv. Hartog) was sown at Corowa, cv. Kulin at Katanning. Sowing fertiliser was applied at the rates of 200 and 80 kg/ha N as nitrate, respectively. Lucerne was cut and suppressed chemically (by setting *radiation use efficiency* = 0) for 14 days from wheat sowing, and cut at six-weekly intervals whenever the cereal crop was not present. A large matrix of simulations was performed, resetting soil water to 5 different levels (100, 75, 50, 25 and 5% maximum plant available water, PAW), and sowing on 6 different dates (21^t April, 11 May, 31 May, 20 June, 10 July and 30 July).

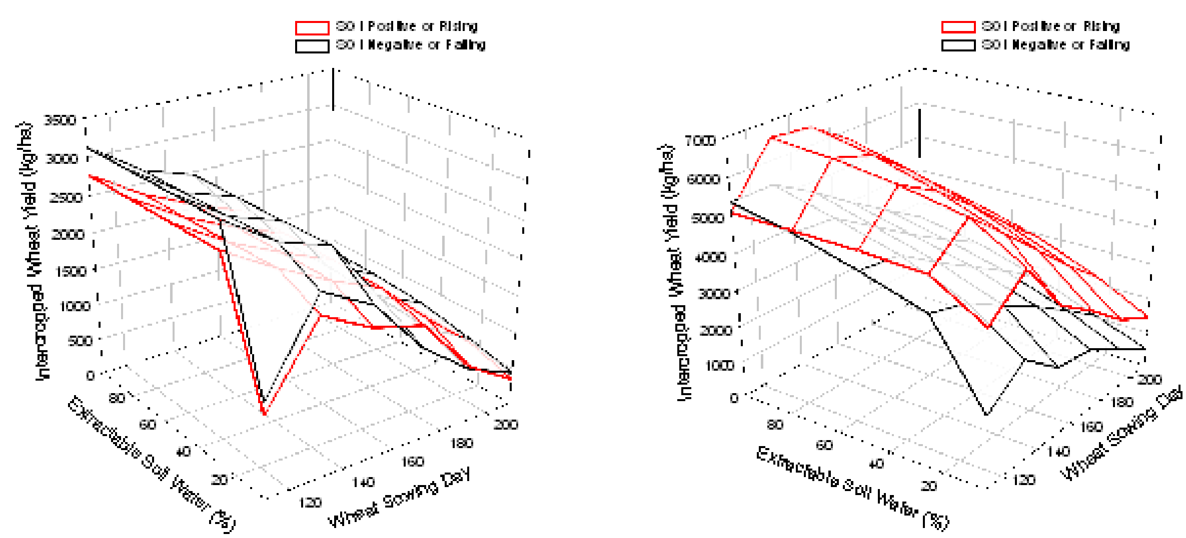
Results

Figure 1 shows average simulated companion-cropped wheat yields for 1957-2003, encompassing a period of 46 years of climate variability at the two sites. Figure 2 shows the simulation results with a fourth dimension added in the form of April-May SOI phase. April-May SOI was positive or rising in 18 out of 46 years, and in 15 years negative or falling.



(a) (b)

Figure 1. Average <u>intercropped</u> wheat yield (kg/ha) at (a) Corowa and (b) Katanning, presented as a function of wheat sowing day and extractable soil water at sowing



(a) (b)

Figure 2. Average <u>intercropped</u> wheat yield at (a) Corowa and (b) Katanning, presented as a function of wheat sowing day and extractable soil water at sowing and April-May SOI phase

Conclusions

Intercropped wheat yields at Corowa are strongly influenced by timeliness of sowing opportunity, soil water at sowing, and the SOI phase prior to sowing. At Katanning, yields are determined primarily by sowing day, with soil water at sowing having little effect as demonstrated by the parallel contours in Figure 1b. At both sites, later sowing of wheat results in more late-season competition with lucerne, as the warmer weather increases lucerne vigour at a sensitive time of the season for wheat growth. Katanning presents a highly winter-dominant rainfall pattern (on average 226mm in-crop) with an average wheat evapo-transpiration of 176mm. Consequently, reliance on stored soil water is low. Corowa rainfall is mildly winter dominant (250mm in-crop) with an average wheat evapotranspiration of 268mm, resulting in a greater dependence on stored soil moisture to maximize cereal production. SOI phase provides negligible skill at Katanning with surfaces intersecting and re-crossing several times in Figure 2b. Corowa presents the more typical east-coast response to SOI with a positive or rising phase indicating greater prospects (on average) for the subsequent intercropped cereal.

References

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