PHYSIOLOGICAL DETERMINANTS OF YIELD AND MATURITY IN ULTRA-NARROW ROW COTTON

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by

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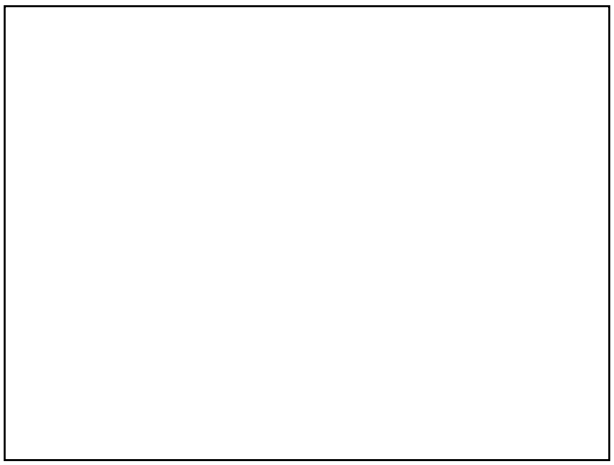

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Abstract

Ultra-narrow row (UNR) cotton, a production system with rows spaced less than 40 cm apart, has been proposed as the ideal system for earlier maturity without substantial yield loss. However, trials in the U.S.A and Australia have found yield and maturity benefits difficult to consistently achieve with UNR cotton production. This thesis aimed to improve the understanding of differences in the growth and development of cotton in conventionally spaced (1 m) and ultra-narrow rows (UNR). Six experiments from 2001-2004 investigated the yield and maturity response of UNR compared with conventionally spaced cotton. In three of these experiments more detailed investigations into the growth and development of UNR cotton were conducted to quantify the physiological determinants of yield and maturity in UNR compared with conventionally spaced cotton. This study focussed on the physiological differences in growth and partitioning, differences in fruit development and retention, and identifying the importance of carbon supply on fruiting dynamics.

The UNR plants in all experiments in this study were smaller, set fewer bolls and maintained yield through a higher plant population, however a smaller plant with fewer fruiting branches did not cut-out earlier. Maturity was not influenced by differences in the time to reach crop development stages between row spacings or by loss of early bolls in the UNR plants. Node of first fruiting branch did not differ between row spacings. Time to first square, retention, time to last effective flower (last flower that was retained to boll maturity) and boll period were also not consistently different between row spacing treatments, which was consistent with maturity not occurring any earlier in the UNR crop.

This study has shown that the plants are smaller due to competition between plants which restricts dry matter production per plant and as a result site production in the UNR plants is slowed and the fewer fruit on the smaller plants are set over the same time period as the greater number of fruit on the larger, more vegetative plants in the conventionally spaced system and cut-out occurs at the same time. This response of slower growth occurred early during the plant's growth before anthesis and led to smaller boll size and lower retention in the UNR plants.

Yield was not significantly different between row spacings in any of the six experiments in this study. However, there was a trend to higher yield in the UNR crop in all of the experiments and a combined analysis found that the mean lint yield of the UNR treatments was 15.9% higher than the conventionally spaced treatments. While early season crop growth, fruit production and light interception tended to be higher in the UNR crop this did not translate into greater final crop biomass production. There was a trend to greater partitioning of carbohydrates to fruit in the UNR crop. Final boll numbers per m^2 were higher in the UNR treatments compared to the conventionally spaced treatments. This was accompanied by a decrease in boll size. However the 9% reduction in boll size in the UNR treatments was more than compensated for by the 21% increase in boll number.

The major factors affecting crop growth and development of the UNR crop in this study were differences between the two row spacings in light interception and conversion efficiency. The UNR treatments had a higher crop light extinction coefficient (k), and hence, greater light capture at low LAI, but this did not lead to increased final total biomass production, most likely because of a compensating reduction in RUE. The higher k in UNR crops would be advantageous to light capture in early canopy development and generate the greater earlier crop growth, supporting early fruit production, leading to the

higher early fruit numbers at the crop level in the UNR crop. However, the associated reduction in RUE would generate reduced crop growth at the higher LAI found after canopy closure, reducing retention of later fruit later in the UNR crop. Hence, the similar total final biomass of the two systems is a consequence of two compensating factors.

For UNR plants to mature earlier, early node production and fruiting site production must be produced at a similar rate to conventionally spaced crops. Further research is needed into whether increasing inputs early in the season will prevent slower growth and development in UNR system, or whether the plants are responding to other indicators such as root competition or changes in the light environment that might lead them to adjust their growth on detection of neighbouring plants. In the case of the latter, either genetic or environmental manipulations might be required to influence plant growth and development in UNR systems.