VARIATION IN RADIATION USE EFFICIENCY IN TEMPERATE RICE

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Abstract

Yield is dependent on the production of biomass and the partitioning of biomass to a product of economic value. Future yield increases will result from improvement in one or both components. This work focuses on improving the efficiency of biomass production, and demonstrates significant variation in the efficiency of conversion of intercepted radiation to biomass. Radiation Use Efficiency (RUE) is measured in g of biomass/MJ of intercepted radiation. Eight cultivars selected from the International Rice Cold Tolerance Nursery had, on average, a 20% higher RUE than current Australian commercial cultivars. This raises the prospect of transferring higher RUE into Australian cultivars, increasing the efficiency of biomass production and laying the foundation for future yield increase.

Key words: Rice, RUE, yield potential, rice physiology.

Average rice yields in NSW are among the highest in the world and have increased approximately 20% since 1990. This reflects improvement in farm practice and the increased yield potential of current commercial varieties.

An active rice physiology research program at Yanco Agricultural Institute seeks to identify physiological traits which will contribute to further yield improve-ment, through improved biomass accumulation, improved harvest index (HI), or both. One aspect of this research involved testing 105 cultivars selected from the 1991 and 1992 International Rice Cold Tolerance Nurseries (IRCTN). This resulted in the identification of 8 cultivars which had greater radiation use efficiency (RUE) than Australian cultivars.

Increased RUE in combination with the phenology of current cultivars would increase biomass accumulation, and, provided HI can be maintained, result in increased yield. Improved RUE in lines with shorter growth duration may allow the current high yield levels to be maintained while increasing the per day productivity of rice production. Both scenarios increase the efficiency of water use, an increasingly important issue with rises in the real price of water.

Materials and methods

Eight of the 105 lines from the International Rice Cold Tolerance Nursery demonstrated higher RUE than Australian lines in an earlier unreplicated experiment. These lines were tested in a replicated trial which included 4 Australian varieties. Each plot (1.4 x 15 m) consisted of eight rows. 150 kg N/ha as Urea was applied immediately prior to flooding. Photosynthetic Active Radiation (PAR) interception was measured weekly from the time at which plots were flooded (at the three-leaf stage approximately 4 weeks after sowing) until full canopy cover. Biomass samples were taken every 14 days in this period to measure biomass accumulation. Plotting biomass against interception gave an accurate measure of RUE.

Results and discussion

There was significant variation for RUE across the twelve varieties (Table 1). The average RUE of the released Australian varieties was 1.08 g/MJ while the average of the international lines was 1.25 g/MJ. However, the shorter duration of the introduced lines limited yield. The longer duration of the Australian varieties led to greater biomass accumulation and thus higher yield. The RUE of cv. HR 4856 was more than 30% higher than the average RUE of the Australian varieties. Therefore the possibility exists to combine the greater RUE of HR 4856 with the phenology of the locally adapted higher yielding Australian cultivar Amaroo, to raise yields. Figure 1 shows the biomass accumulation of such a hypothetical variety (HYV), with a final biomass more than 2t/ha greater than Amaroo. Assuming a harvest index of 0.5, this

represents an additional 1 t/ha in grain yield. The success of such an approach rests on the development of efficient indirect selection for increased RUE in segregating pop-ulations and its combination with high HI.

Conclusion

HR 4856 is one of five varieties that was recommended to the Australian rice breeders as a potential parent because of its high RUE. The identification of high growth lines among newly introduced varieties is a very exciting development and paves the way for continued improvement of higher yielding varieties for the Australian Rice Industry.