

NEAR ISOGENIC LINES OF CV. MERCIA DIFFERING IN DWARFING GENES IN CONTRASTING PRODUCTION SYSTEMS

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Introduction

The incorporation of major genes conferring semi-dwarfism in wheat breeding programmes has often led to significant yield improvements (Gale & Youssefian 1985). However, the relative performance of different dwarfing genes depends upon environment and genotypic background (Flintham *et al.* 1997). Reduced height (*Rht*) alleles have been studied for their pleiotropic influences on grain yield but less is known about their effects on resource use efficiency in contrasting production systems. Here we report the performance and use-efficiencies of cv. Mercia incorporating different *Rht* alleles, in neighboring experiments receiving contrasting levels of synthetic input.

Materials & Methods

Wheat was grown on neighbouring *conventional* and *organic* areas within a single field at The Crops Research Unit, The University of Reading, UK (51° 29' N, 0° 56' W). Seven near isogenic lines of winter wheat cv. Mercia varying in dwarfing genes [Tall (*rht*), semi-dwarf, (*Rht1-B1b*, *Rht1-D1b*, *Rht8c*), and dwarf (*Rht1-B1c*, *Rht-D1c*, *Rht12*)] were drilled on 21 September 2005 at 300 seeds/m² in 2 x 10m plots, randomized in four blocks.

The *conventional* experiment received 200 KgN/ha as ammonium nitrate at stem extension and was protected with a robust spray programme. The *organic* experiment was established after three years of clover-rich ley and received no sprays. Photosynthetically active radiation (PAR) was measured during the season above and beneath the canopy with a AccuPAR LP-80 ceptometer (Decagon Devices Inc). At maturity plant height was measured on ten plants per plot and a destructive 0.5 m² was sampled per plot to assess weed biomass and crop harvest index. Grain yield was assessed from a combine harvest and crop nitrogen was assessed after oxidative combustion using a LECO FP-528. Nitrogen utilization efficiency to produce grain (NUE_g) was calculated as grain dry matter yield / nitrogen in the above ground biomass.



Fig. 1. Variation in autumn plus winter growth amongst isogenic lines

Acknowledgements

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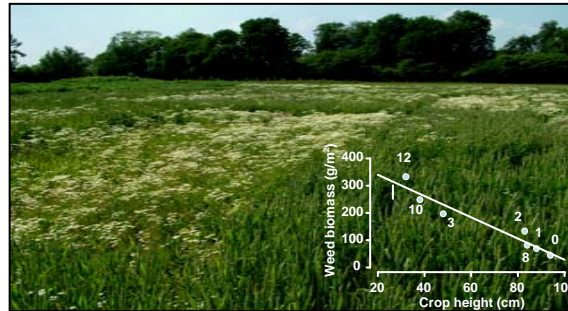


Fig. 2. Prevalence of weeds on dwarf genotypes in an organic system. See Fig. 3 for key to graph.

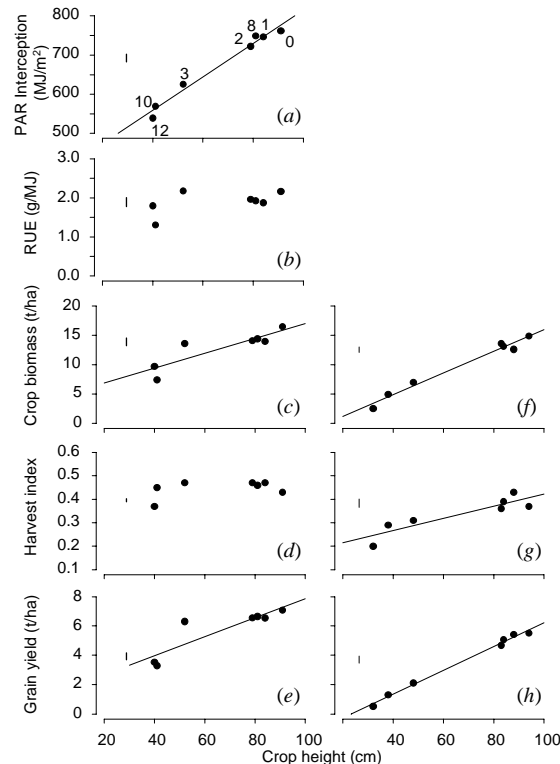


Fig. 3. Interception of PAR, its use-efficiency (RUE) for producing above ground crop biomass, harvest index, and grain yield for near isogenic lines of cv. Mercia differing in dwarfing genes (0, 1, 2, 3, 8, 10, 12 correspond to *rht*, *Rht1-B1b*, *Rht1-D1b*, *Rht1-B1c*, *Rht8c*, *Rht-D1c*, *Rht12* respectively), grown *conventionally* (a-e) and *organically* (f-h). Vertical bars are s.e.d. (18 d.f.).

Results

On average semi-dwarf and dwarf alleles reduced crop height by 8 to 13% and 46 to 61% respectively. In the *conventional* experiment, crop height was strongly and positively associated with PAR interception (Fig. 3) and above ground nitrogen at maturity (Fig. 4). Significant associations were also observed between height and crop biomass, grain yield and nitrogen utilization efficiency but in all cases *Rht1-B1c* gave higher values than would have been predicted by height. No relationship was observed between crop height and radiation use efficiency and harvest index. In the *organic* experiment, reduced height was associated with: increased weed biomass (Fig. 2); and reduced crop biomass, harvest index, grain yield (Fig. 3), total nitrogen uptake and utilization efficiency (Fig. 4).

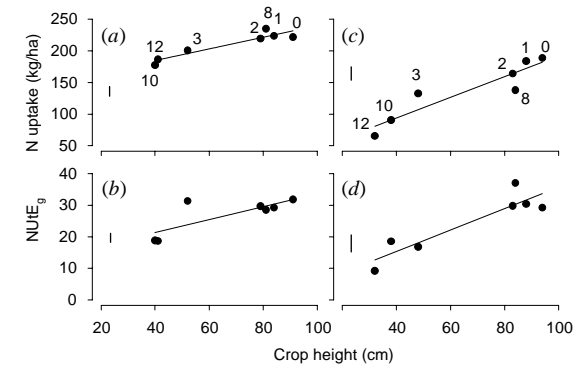


Fig. 4. Relationships between height of near isogenic lines of cv. Mercia differing in dwarfing genes and nitrogen uptake and utilization efficiency when grown *conventionally* (a,b) and *organically* (c,d). For key see Fig. 3.

Discussion

We confirm that when major genes are associated with resultant crop heights below about 80 cm, in UK conditions, grain yield is often reduced (Flintham *et al.* 1997). We show that this yield reduction can be associated with reduced PAR interception (rather than radiation use efficiency) in a conventional system, and increased weed prevalence in an organic system. The poorer performance of *Rht1-B1c* in the *organic* context, and also the negative relationship between harvest index and height in just that experiment, suggest that stature is more important in extensive systems to improve competition against weeds and thus contribute to dry matter partitioning to grain. We demonstrate that dwarfism can be associated with reduced nitrogen uptake and utilization efficiency.

Flintham, J.E., Borner, A., Worland, A.J. and Gale, M.D. 1997. Optimizing wheat grain yield: effects of *Rht* (gibberellin-insensitive) dwarfing genes. *Journal of Agricultural Science* **128**, 11-25.

Gale, M.D., and Youssefian, S. 1985. Dwarfing genes in wheat. In: *Progress in Plant Breeding* (ed. G.E. Russel), pp. 1-35. Butterworth, London.