East-west crop row orientation improves wheat and barley grain yields

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KEY MESSAGES

- Grain yields of wheat and barley were significantly higher when sown in an east-west orientation than in a north-south orientation.
- Under an east-west orientation there was less weed growth, higher light interception by the crop canopy and higher soil moisture than in the north-south orientation.
- No definite pattern in the impact of row orientation on the yields of lupin, canola and field pea was determined with conflicting results between orientations. Further research is required.
- Farmers should consider these results when establishing tramline systems or sowing wheat and barley in areas similar to Avondale or Merredin.

AIMS

Crop row orientation is an important factor in regulating crop/weed competitive relationships, growth and yields. Crop rows orientated at a near right angle to sun direction may suppress weed growth by creating a partial shade on weeds, however such effects have rarely been observed in many parts of the world. In some parts of the Western Australian wheat belt the sun angle goes as low as 35° during winter time. By investigating this phenomenon in WA it can be determined if the opportunity exists for growers to capitalise on the concept of row orientation, particularly when establishing tramline farming.

The aim of this study was to examine the effect of crop row orientation induced photo-sensory processes on the growth and development of weeds and crops.

METHODS

Merredin trials

Two trials were conducted at the Merredin Research Station in 2004 and 2005. In 2005, ryegrass seed was introduced at seeding at a density of 200 ryegrass seed/m^2 to ensure weediness. Five crops (wheat, barley, lupins, canola and field pea), were sown at two row spacings (23 and 60 cm) and two row orientations (east-west and north-south). An additional trial was conducted under weed-free conditions to examine the effect of crop row orientation on the growth and development of wheat and barley. The crops were sown on 11 May 2005 following standard agronomic practices.

In 2004, 200 ryegrass seeds/m^2 and 300 wild radish pod segments/m^2 were introduced into the site at sowing time. Five crops (wheat, barley, lupins, canola and field pea) were sown at two row spacings (18 and 36 cm) and two row orientations (east-west and north-south). The crops were sown on 4 June following standard agronomic practices.

All treatments in both years were laid out in a factorial complete block design with three replicates. No pre- or post-emergent herbicides were sprayed for weed control in 2004, although Select® was inadvertently sprayed in broadleaf crops only in 2005. The measurements included density of crops and weeds by species, weed dry biomass, soil water content, light interception, grain yield, grain size and protein content. Photosynthetically active radiations (PAR) were measured above the crop canopy and at the centre of inter-row apace at midday on a sunny day, with a Sunfleck Ceptometer. Measurements were reported as per cent light interception in relation to light above the crop canopy.

Avondale trials

Two trials were conducted at the Avondale Research Stations in 2002 and 2004 using natural populations of ryegrass and radish. Five crops (wheat, barley, lupins, canola and field pea) were sown at two row spacings (18 and 36 cm) and two row orientations (east-west and north-south). The crops were sown in the 1st week of June following standard agronomic practices. All treatments were laid out in a factorial complete block design with three replicates. No pre- or post-emergent herbicides were sprayed for weed control. The measurements included density of crops and weeds by species, weed dry biomass, light interception and grain yield and protein.

RESULTS

Results show that there was a significant increase in the grain yield of wheat and barley when the crops were sown in an east-west orientation compared to a north-south orientation at both locations in all seasons (Table 1).

Table 1. Grain yield (kg/ha) measured on opposing orientations of wheat and barley in four trials at two locations, averaged over row spacings from 2002 to 2005. Lsd$_{05}$ to compare means of each crop between orientations

Growing seasons and locations	Wheat (kg/ha)		Barley (kg/ha)		lsd (p = 0.05)
	East-West	North-South	East-West	North-South	
2005 Merredin	1159	666	1151	1069	141
2004 Merredin	766	615	717	439	127
2004 Avondale	na*	na	502	456	85
2002 Avondale	2851	2020	2183	1722	317

* na = not available.

Yield data of canola, lupin and field pea are conflicting between locations, at one location yields of these crops were higher in the east-west orientation than the north-south orientation, and vice versa at the other location (data not presented).

Under weed free conditions at Merredin, wheat and barley yields were also 24 to 30 per cent higher when sown in an east-west orientation than north-south orientation presumably due to 11 to 18 per cent higher soil water in an east-west orientation than north-south orientation, measured at the centre of inter-row space at late flowering stage.

Row spacing effects varied between crops irrespective of sowing orientation (data not presented). Grain protein content of wheat and barley was higher in the east-west orientation than in the north-south orientation measured at Merredin (Figure 1). Grain sizes were not influenced by row orientations.

The initial weed densities did not significantly differ due to row orientations (data not presented). However, weed dry biomass was lower in crops sown in the east-west orientation than in the north-south orientation both at Avondale and Merredin (Table 2).

Table 2. Weeds dry biomass (g/m2) measured at flowering stage of crops from opposing orientations of wheat and barley at two locations, averaged over row spacings from 2002 to 2005. Lsd$_{05}$ to compare means of each crop between orientations

Growing seasons and locations	Weed dry biomass in wheat (g/m^2)		Weed dry biomass in barley (g/m^2)		lsd (p = 0.05)
	East-West	North-South	East-West	North-South	
2005 Merredin	8.1	28.1	10.3	18.6	12.0
2004 Merredin	45.5	59.4	55.4	69.9	4.8
2004 Avondale	na*	Na	114.1	149.6	24.5
2002 Avondale	11.9	62.2	8.1	64.0	31.8

* na = not available.

The lower weed biomass in the east-west orientation than in the north-south orientation was presumably due to a reduction of weed growth. This may have occurred due to a change in the light quality induced by shade from crop plants sown in an east-west orientation and higher light interception by the crop canopy.

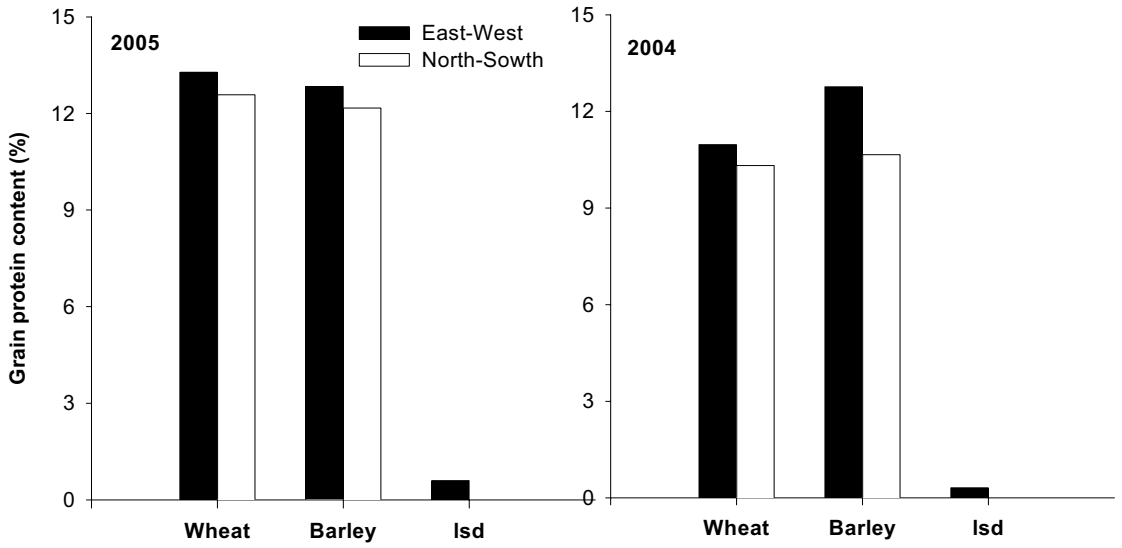

Figure 1. Grain protein content (%) measured on opposing orientations of wheat and barley at Merredin, averaged over row spacings in 2004 and 2005. Lsd.$_{05}$ to compare means of each crop between orientations.

Total light interception by crop canopy of wheat and barley was always higher in east-west orientation than in north-south orientation when measured at midday at the centre of inter-row space (Figure 2). This means the cop plants in the east-west orientation created more shades on the weed plants growing in close proximity on the south side of crop rows than the crop plants in the north-south orientation.

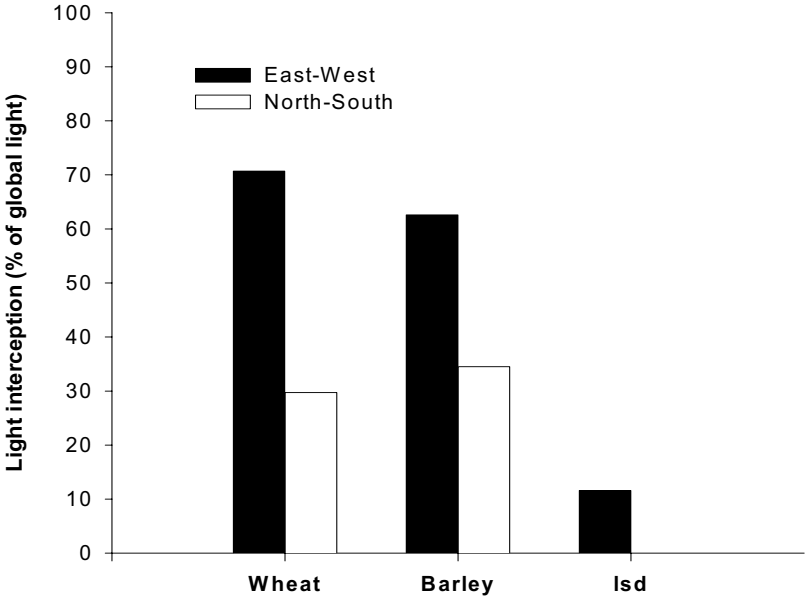

Figure 2. Light interception, expressed as per cent of global light, by crop canopies in two row orientations measured at midday on a sunny day in September at the centre of inter-row space, averaged over row spacings and locations. Lsd.$_{05}$ to compare means of each crop between orientations.

It appears that grain yields of wheat and barley were consistently higher when sown in an east-west orientation than in a north-south orientation. Such increases in the yield of these crops could be attributed to a reduction in weed growth in the east-west orientation compared to a north-south orientation. It may be possible that shade created by crop plants in the east-west orientation not only changed the quality of intercepted light but also maintained a lower soil temperature, leading to 11-18 per cent higher soil water in the east-west than in north-south orientation. The grain size did not, however, support such observation on higher water availability in the east-west than north-south orientation.

CONCLUSION

The results from this study may have vital implications in guiding growers as to whether they should sow crops in an east-west or north-south orientation.

Sowing cereal crops in an east-west orientation is likely to be more productive than in a north-south orientation in the absence or presence of weeds.

More research is needed to understand the influence of row orientations on the yields of lupin, canola and field pea.

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KEY WORDS

Light interception, row orientation, weeds biomass, grain yields, grain protein.

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