Growing organic cereals in Northern Ireland – disease and weed problems

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Summary

The small organic arable sector in N. Ireland could be expanded to provide winter feed for cattle. Spring barley or wheat are likely to be the most suitable crops as they are reported to have fewer weed and disease problems than winter cereals. Trials from 2003 –05 on weed control showed no consistent effect of cultivar, although higher seed rates reduced weed biomass and tended to increase yield, albeit marginally. Trials on disease control showed no synergistic effects of two- or three-way cultivar mixtures over single cultivars, although disease levels were generally low. Particularly in spring barley, results from mixtures tended to be averages of those of individual components. It is suggested that it may be more advantageous and practical to use the most highly-disease resistant or tolerant cultivars rather than concentrate on mixtures.

Key words: Organic agriculture, weeds, *Rhynchosporium secalis*, *Mycosphaerella graminicola*, spring barley, spring wheat

Introduction

The N. Ireland organic sector is relatively small and tends to be concentrated on poultry, beef and sheep production, rather than on arable. However, organic cereals are needed for winter-feeding for organic cattle. A small survey of organic cereal farmers was carried out by the authors, before the work reported in this paper, to ascertain the main problem areas. The survey indicated that the main area of concern, as elsewhere in Britain (Welsh *et al*., 1999) was weed control, followed by disease control. However, both of these areas were considered to be less of a problem with spring-grown rather than winter-grown cereals. The research was therefore targeted on spring barley and wheat. Two particular areas were examined – the effect of cultivar on weed growth and the effect of cultivar mixtures on disease control.

Materials and Methods

From 2003–2005, two spring barley trials and one spring wheat trial were carried out each year. In one of the spring barley trials and in the spring wheat trial, disease levels and yields of single cultivars were compared with two-way and three-way mixtures. For spring barley, cultivars

Annabel, Dandy, Static and Riviera (2003 only; replaced by Hart in 2004–05 because of lack of availability) were used; for spring wheat, cultivars Ashby, Chablis and Paragon. Disease and Green Leaf Area (GLA) were assessed on the top three leaf layers at a number of Growth Stages (only GS 80/85 is reported in the present paper) and analysed after arcsin % transformation. The second spring barley trial investigated the effect of two cultivars, Dandy and Hart (or Riviera), sown at rates of 400, 450, 500, and 550 seeds m^{-2}. At *ca* GS 91, 0.5 m^2 squares were randomly removed from each plot and dry weights of individual weed species and crop measured. Grain yields were measured from all three trials and expressed as t ha^{-1} at 15% moisture content; thousand grain weights were measured dry. All trials were carried out at Greenmount Agricultural College, Co. Antrim on land which was initially in conversion but since 2004 has been certified as organic. Trials were on plots of 12 m × 1.4 m, and treatments replicated four times. Analysis was by regression and ANOVA using the Genstat statistical package.

Results

Effect of cultivar and seed rate on weed levels in spring barley

In 2003, there were no significant effects of seed rate or cultivar on weeds or crops. In both 2004 and 2005, however, increasing seed rate significantly reduced weed biomass (P = 0.011, 0.041 in 2004 and 2005 respectively) although there were no significant increases in crop biomass or grain yield. When data for all three years were combined there was a trend towards decreased weed biomass with higher seed rates (P = 0.078). Fig. 1 is a regression of weed and crop weight on stand count for 2003–05 and shows the significant relationship between stand count (resulting from seed rate) and weed biomass, but none with crop biomass. Nevertheless, when data were meaned over years, the correlation of stand count with yield approached significance (R^2 = 0.88; P = 0.061) increasing from 4.83 t ha^{-1} to 5.00 t ha^{-1} when going from 340 seeds m^{-2} to 420 seeds m^{-2}. Hart/Rivera out yielded Dandy by 0.5 t ha^{-1} over 4.6 t ha^{-1}, but there were no consistent effects of cultivar on weed suppression.

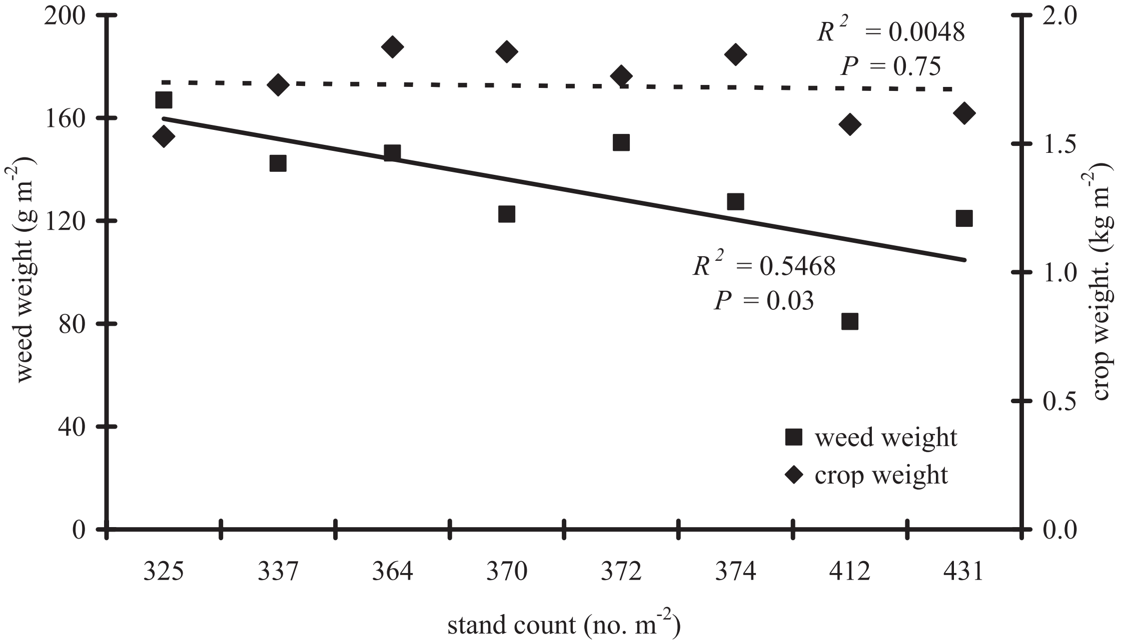

Fig. 1. Regression of weed weight (g d.m. m^{-2}) and crop weight (kg d.m. m^{-2}) on stand count of spring barley, sampled at *ca* GS 91 and meaned across years 2003–05.

The most commonly and consistently observed pathogens were *Rhynchosporium secalis* (leaf blotch) on spring barley and *Mycosphaerella graminicola* (*Septoria tritici* blotch) on spring wheat. However, the level of disease in all trials across the years was generally very low and this led to few significant differences between single cultivars and cultivar mixtures. Apart from the lowest levels of *R. secalis* being on the three-way mixtures in 2005 (0.9 arcsin % compared with 3.2 and 7.1 for single cultivars and two-way mixtures respectively; $P = 0.027$), there was little evidence that cultivar mixtures had any effect in reducing disease in either crop.

Differences in GLA of spring barley between the various cultivars and cultivar mixtures were significant in 2005 (leaf 1, $P < 0.001$; leaf 2, $P = 0.028$) and approached significance in 2003 ($P = 0.059$, leaf 1) and when all data for leaf 2 were analysed together ($P = 0.057$). However, these differences did not indicate any synergistic effects of mixtures - GLAs for mixtures were close to the average of the single cultivars of which they were composed and there was a significant correlation between actual values and those predicted from averages of the individual components (Fig. 2). Although the GLA was on average highest in the three-way mixtures (Table 1a), this was not consistent across years. Differences in GLA of spring wheat between cultivars and cultivar mixtures only approached significance in 2003 (leaf 2, $P = 0.066$), but not in other years. There was no clear effect of mixtures (Table 1b) and the averaging effect noted with spring barley was absent.

Although there were significant yield differences in spring barley between cultivars and cultivar mixtures in 2004 ($P = 0.001$) and 2005 ($P = 0.01$), there was no synergistic effect. As for GLA, the yields of mixtures were averages of the individual components with a significant correlation between actual and predicted values ($R^2 = 0.40$; $P = 0.048$). Although yields were highest for the three-way mixtures (Table 1a), consistency across years was as poor as it was for GLA. There were no overall effects of mixtures on yield of spring wheat and no averaging effects (Table 1b).

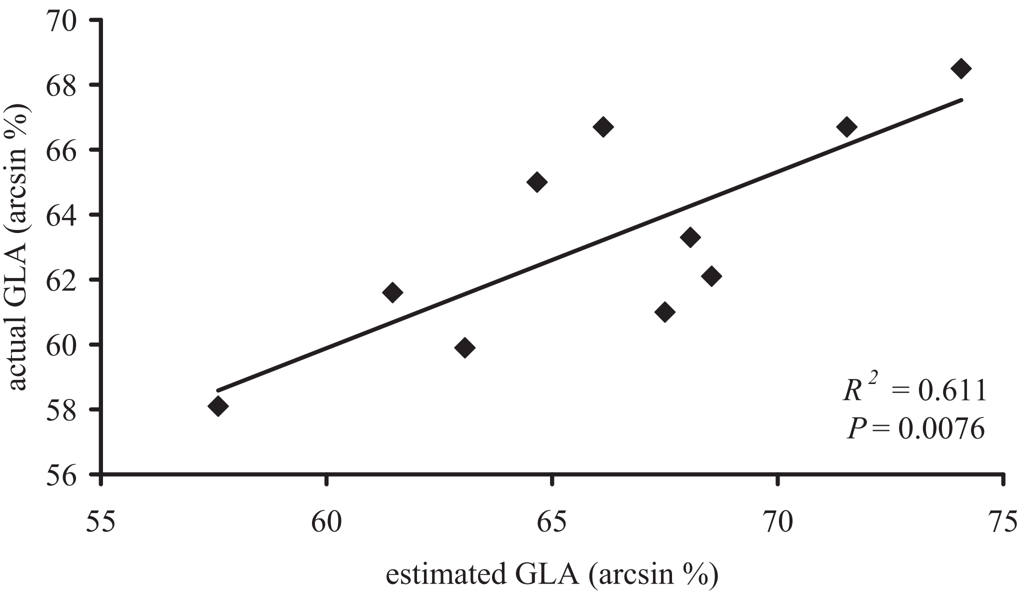

Fig. 2. Actual GLA (arcsin %) of leaf 2 at GS 80/85 for 2- and 3-way spring barley mixtures *vs* GLA (arcsin %) estimated from single cultivars, 2003–05.

Although there were some significant differences in thousand grain weights between cultivars and cultivar mixtures of both spring wheat and barley (e.g. spring barley in 2003 ($P = 0.016$) and spring wheat in 2005 ($P < 0.001$) there were again no synergistic effects. There was a tendency towards averaging in spring barley and no clear effect in spring wheat. There were no obvious differences between averages for single, and two and three- way mixtures (Table 1).

Table 1. *Green leaf area of leaf 2 at GS 80/85 (arcsin %), yield (t ha-1 at 15% moisture) and thousand grain weight (g dry) of single cultivars and 2- and 3-way mixtures of (a) spring barley; (b) spring wheat, 2003–05*

Cultivar mixture	Green leaf area				Yield				Thousand grain weight			
(a)	2003	2004	2005	Mean	2003	2004	2005	Mean	2003	2004	2005	Mean
single	59	66	65	63	7.27	4.99	3.69	5.31	44.6	40.4	40.4	41.5
2-way	65	68	61	65	6.97	5.06	3.35	5.13	44.1	42.3	41.0	42.5
3-way	70	66	71	69	7.25	5.09	4.07	5.47	44.6	41.3	40.9	42.3
(b)	2003	2004	2005	Mean	2003	2004	2005	Mean	2003	2004	2005	Mean
single	71	37	86	65	3.77	3.52	4.47	3.92	48.3	38.0	42.6	43.0
2-way	68	34	85	62	3.31	3.37	4.49	3.72	46.9	38.5	43.9	43.1
3-way	66	34	85	62	3.58	3.64	4.50	3.91	47.1	38.8	43.9	43.3

Discussion

Although there was no clear effect of cultivar on weed control, only two cultivars were examined and it is possible that a wider selection would have shown an effect. More work is needed to arrive at an optimum seed rate to reduce weeds and increase crop yields. Cultivar mixtures have generally been considered to have a role in protecting crops against disease (e.g. Wolfe, 1990). However, this was not demonstrated in the present work, possibly because of low disease levels. It is possible that it might be better to concentrate on the most disease-resistant or tolerant cultivars rather than on mixtures with their inherent agronomic differences.

References

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