Comparative growth and competition of wild radish (*Raphanus raphanistrum* L.) and wheat

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Abstract

The effects of various densities of wild radish (*Raphanus raphanistrum* L.) and wheat on the growth and reproductive output of each other were investigated in a field trial at Roseworthy, South Australia in 2003. The experiment was established as a factorial combination of wheat (0, 100, 200 and 400 plants/m^2) and wild radish (0, 15, 30 and 60 plants/m^2) densities. The presence of wild radish in wheat reduced shoot dry matter and grain yield of wheat with the magnitude of this reduction dependent on weed density. The variation in wheat grain yield was largely related to the changes in the density of wheat ears. Increasing the density of wheat substantially reduced the adverse effects of wild radish on wheat. As crop density increased, weed dry matter and pod production per unit area decreased. Wild radish pod weight/m^2 was negatively correlated with wheat density ($r = -0.70$, $P < 0.01$) and wheat grain yield ($r = -0.81$, $P < 0.01$). This indicated that higher densities of wheat were able to suppress pod production of this weed species. From a practical view point, this study shows that increased wheat density in the range of 200-300 wheat plants/m^2 can reduce wild radish pod production and may also give some reduction in crop yield loss. The data collected will be used to develop a simulation module based on the APSIM platform.

Media summary

Increased wheat density provided useful suppression of wild radish and reduced its seed production.

Key Words

Raphanus raphanistrum, crop density, weed density

Introduction

Wild radish (*Raphanus raphanistrum* L.) is a highly competitive weed that is widely distributed throughout the cropping areas of southern Australia (Cheam and Code 1995). Indeed, it is the principal broadleaf weed of Australian winter rainfall areas and causes large yield losses.. The weediness of the species has been attributed to its strong competitive ability with crops, flexible germination requirement, high reproductive capacity, seed dormancy and seed-bank longevity, the presence of herbicide resistant populations and its ability to emerge and set seed at various times of the year (Blackshaw and Lemerle 1999; Code and Donaldson 1996).

A successful integrated weed management program for the control of wild radish cannot be implemented without a clear understanding of inter-specific competition between wild radish and major field crops. For this purpose, a good knowledge of population dynamics of wild radish is also a necessity. Many studies have documented the effects of densities of wild radish on the reduction of wheat yield. However, there are few reports in the literature of the comparative growth of wheat and wild radish in monoculture and mixtures. Therefore, the present study was conducted to determine the effects of various densities of wild radish and wheat on their growth and reproductive output.

Material and Methods

Site characteristics

A field experiment was conducted in the 2003 growing season at the University of Adelaide farm at Roseworthy, SA. The soil at the site was a red earth sandy loam and the area has a climate, which is characterised by cold wet winters and hot dry summers.

Treatments and design

Treatments consisted of four densities of wild radish (0, 15, 30 and 60 plants/m^2) and wheat (0, 100, 200, 400 plants/m^2). The factorial set of treatments was arranged within a randomized complete block design with three replicates. Individual plot size was 1.4 m wide by 10 m long. Glyphosate was applied for general weed control to the entire plot area before seeding. Fertilisers (as 123 kg/ha urea and 70 kg/ha di-ammonium phosphate) were drilled with the crop at sowing. Wheat (*cv.* Krichauff) was sown on 10th June 2003 with a cone seeder in rows 18 cm apart. The seeds of wild radish were broadcast by hand on the soil surface immediately after sowing the wheat.

Measurements

Both wheat and wild radish plants were sampled following the three leaves on the main stem of the wheat, at approximately 2 weekly intervals until anthesis (of wheat) and then one sample (of both plants) was taken at the maturity of wheat. However, data are presented here only for the final harvest taken at crop maturity. After maturity, the number and weight of wild radish pods, 1000-grain weight and the final yield of wheat were measured.

Data analysis

For this paper, linear and non-linear regression equations and correlations were fitted to the data.

Results and Discussion

Crop yield

Depending on crop and weed density, wheat yields varied from 2.6 – 4.9 t/ha. Wild radish plant density had a significant negative effect on crop yield ($r = -0.50$, $P < 0.01$). It also decreased the leaf area and dry matter of wheat over the entire growing season (data are not shown). Irrespective of wheat density, an increase in wild radish density caused a significant reduction in wheat grain yield (Figure1). Among the crop yield components, ear number per square metre had the greatest influence on crop yield ($r = 0.84$). The number of grains per ear and 1000-grain weight did not show a strong association with yield (Table 1). Crop density had a positive influence on ear density ($r = 0.74$) and grain weight ($r = 0.47$). As expected due to intense intra-specific competition at higher wheat densities, there was a negative association between wheat density and grains/head ($r = -0.64$). In other words, at higher wheat densities the number of heads per square metre increased but at the same time there was a consistent decline in the number of grains per head. There was a negative association between grains/ear and 1000-grain weight ($r = -0.63$) indicating competition for assimilates when large numbers of grains are being filled in an individual ear. Interestingly, there was a significant negative correlation between pod weight/plant of wild radish and 1000-grain weight ($r = -0.60$). This relationship may be a reflection of competition between these species for water during the grain filling stage.

Table 1. Correlation coefficients between the parameters of growth and yield in wheat and wild radish[A]

	Pod weight/m^2	Yield	Ear No./m^2	Grain No./ear	1000 grain weight
Crop No./m^2	-0.70	0.60	0.74	-0.64	0.47

Weed No./m^2	0.67	-0.50	-0.56	-0.35	0.37
Pod weight/m^2	1.00	-0.81	-0.86	0.17	0.10
Pod weight/plant	0.50	-0.66	-0.36	0.64	-0.60
Yield	-0.81	1.00	0.84	0.02	0.007
Ear No./m^2	-0.86	0.84	1.00	-0.43	0.21
Grain No./ear	0.17	0.02	-0.43	1.00	-0.63

[A] r = ?0.30 (P<0.05); r = ?0.393 (P<0.01)

Weed growth and seed production

Pod production by wild radish plants was reduced by increasing wheat density (r = -0.70). The slope of linear regression between wild radish density and its pod production (g/m^2) declined with increasing wheat density. This clearly indicates that at higher densities wheat was able to compete more effectively with wild radish and reduced its reproductive output (Table 2). The slope of this linear regression was nearly halved as wheat density increased from 100 to 300 plants/m^2 (based on actual established densities).

Table 2. The linear regression equations for the relationship between wild radish density and its pod production (g/m^2) over a range of wheat densities.

Wheat density (plants/m^2)	Equation	Correlation coefficient (r)
0	RSP[1] = 2.26X + 92.61	0.83**
100	RSP = 2.04X + 33.59	0.86**
200	RSP = 1.99X + 9.75	0.95**
400	RSP = 1.06X + 15.44	0.80**

[1] RSP = radish seed production; ** P < 0.01

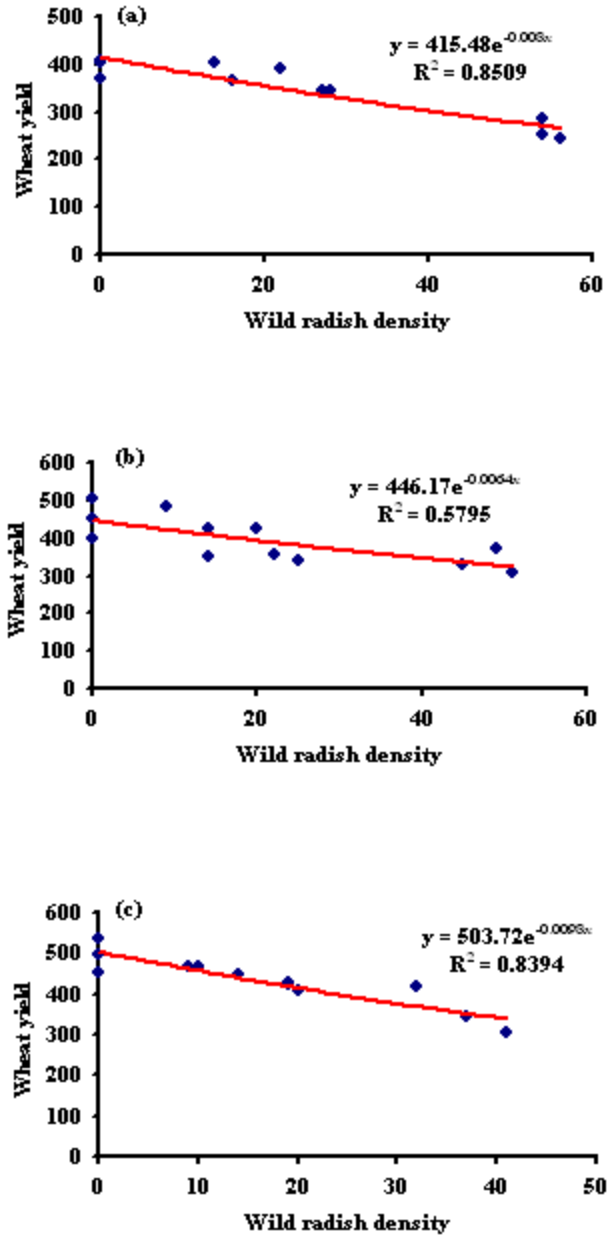

Figure 1. Effects of different densities of wild radish and wheat plants (plants/m^2) on wheat grain yield (g/m^2) when sown at (a) 100, (b) 200 and (c) 400 plants/m^2.

Conclusion

The results clearly show the effects of inter-specific competition between wheat and wild radish. In this study, wheat responded positively to increased crop density both in the presence and absence of wild radish. Consequently, the reduction in crop yield loss (%) due to increased crop densities was relatively small. However, increases in crop density had large effects on the reproductive output of wild radish. Increase in wheat density from 100 to 300 plants/m^2, halved the seed production of wild radish plants.

The results indicate that increased crop density could be a useful tool in an integrated weed management program for wild radish, particularly in reducing the seed output of this troublesome weed.

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