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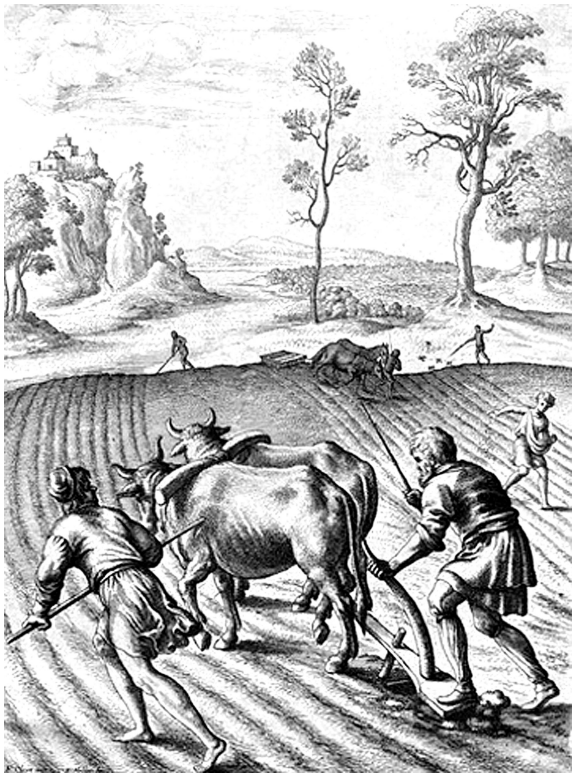

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Competitive Ability of Different Weed Species

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Abstract: A range of weed species were grown in all combinations with four crop species (wheat, barley, bean and oilseed rape) under field conditions of 1990-91. The weeds were ranked on the basis of their competitive abilities. The degree to which competitive ability was specific to particular combination of crops and weed species was examined. Two indices-crop equivalent and aggressivity were compared to measure the competitive ability of the weeds. Based on aggressivity the ranking order of the weeds for their competitive abilities was, cleavers (*Galium aparine* L.)> wild oats (*Avena fatua* L.)> field speedwell (*Veronica persica* Poir.)> common chickweed (*Stellaria media* L. Cyrill.)> scented mayweed (*Matricaria recutita*). The ranking of the weeds varied depending on the associated crop and at different growth stages. There was a poor correlation between crop equivalent and aggressivity.

Key words: Competitive ability, weeds, aggressivity, crop equivalent, crops

Introduction

Competitive ability is a function of many attributes of a weed which results in the weed gaining a larger proportion of limiting resources than the crop (Holt, 1988). It is important to know the competitive ability of weed for assessing the degree of harm to crops. There is an increasing awareness of environmental pollution caused by an extensive use of agro-chemicals mainly pesticides in the production systems. Presently some cosmetic applications of herbicides have been identified and suggestions are being put forward to calculate economic threshold weed density for spraying. To calculate the economic threshold density of a weed, the knowledge of competitive ability of the weed is essential.

Although there have been many studies on the competitive ability of various weeds when grown with a given crop (Welbank, 1963; Farahbakhsh *et al.*, 1987; Wilson and Wright, 1990), very few studies have been done in which a range of weeds were grown with a range of crop species, so that possible differences in ranking could be made. Therefore, the present investigation was undertaken to study the competitive ability of five weed species against four crop species.

Materials and Methods

The experiment was conducted in the experimental grounds of the Plant Science Laboratories, at the University of Reading, UK during the period from October 1990 to August 1991. The details of weed and crop species with their sowing and harvest dates are given in Table 1. The crop seeds were sown at row spacing of 15 cm in plots (3x2 m^2) at target densities of 300 plants m^{-2} for wheat, barley and rape and 70 plants m^{-2} for field bean, placing the seeds at a depth of 3-4 cm. Weed seeds were sown in the crop rows at a target density of 200 plants m^{-2} at a depth of 1-2 cm, with an exception that seeds of mayweed were sown at the soil surface. Each of the crops was also grown in the absence of weed and the weeds were also grown without crops. The treatments were arranged in a split-plot design where the crops constituted the main plots and the weed species constituted the sub-plots. The weed species were sown in alternative single rows i.e. the treatment rows were separated by a single pure row of the crop as described by Satorre (1988) as "Standard border design". No chemical fertilizer was added since the plots were previously treated with mushroom compost. The population of crops and weeds were measured after 120 days of sowing. Unwanted weeds were removed time to time to avoid extra competition. Destructive samplings of four weed plants and four crop plants were made periodically from two border areas of each treatment row at random. The central one metre of each treatment row was reserved for final harvest. The harvested plant materials were dried in an oven at 800°C for 72 h to record dry weight.

For measuring the competitive ability of the weeds, crop equivalent (CE) and aggressivity (AGGR) values of the weeds were calculated according to the following formulae:

$CE = W_{ab}/W_{bb}$ (Wilson, 1986)

$AGGR = (W_{ab}/W_{aa})-(W_{ba}/W_{bb})$ (McGilchrist and Trenbath, 1971)

where W_{aa} and W_{bb} are the weights per plant of species 'a' (weed) and 'b' (crop) when grown in monocultures and W_{ab} and W_{ba} are the per plant weights of the species in mixtures with each other. The data were analyzed statistically by using the statistical package GENSTAT V. Plant weight of weeds and crops were transformed

Table 1: Details of experimental treatments with sowing and harvest dates

Weed species	Wild oat, cleavers, field speedwell, common chickweed and scented mayweed
Crop species	Wheat (cv. Mercia), Barley (cv. Igri), Oilseed rape (cv. Banner)
Soil type	Clay loam
Sowing time	19 - 20 October
Sampling dates:	1st sample - 10 April, 2nd sample - 9 May, 3rd sample - 20 July
Final harvest	30 July - 7 August

Table 2: Mean shoot weight (g $plant^{-1}$) of the weed species as affected by the competition from four crops. Values are geometric means of three harvests

	Crop species						
Weed species	Bean	Wheat	Barley	Rape	Weed mean	No crop mean	% loss
Cleavers	1.39	0.45	0.28	0.93	0.76	1.78	57.3
Wild oat	0.08	0.26	0.17	0.59	0.28	2.41	88.4
Chickweed	0.18	0.61	0.28	0.64	0.43	2.30	81.3
Speedwell	0.31	0.42	0.16	0.58	0.37	1.54	76.0
Mayweed	0.02	0.04	0.01	0.02	0.02	1.51	98.7
Crop mean	0.40	0.36	0.18	0.55	0.37	1.91	

LSR (5%): Weed means = X 1.28, Crop means = X 1.17, Crop X weed = X 1.58

to loge before analysis; the data presented are geometric means and least significant ratio (LSR) are presented. The mean values of other data were compared using LSD.
Correlation between percent yield loss and two competitive indices were studied. Finally comparison between CE and aggressivity was studied.

Results and Discussion

Weed establishment: In general, weed emergence was less than the desired target density. However, the mean density of the weeds in pure stands and in mixtures was similar.

Table 3: Mean log shoot weight (g plant^{-1}) of the weed species at different harvest dates. Values are arithmetic means of four crops

	Harvest dates			LSD
Weed species	10 April	09 May	20 July	(P = 0.05)
Cleavers	-0.43	-0.14	0.16	0.38
Wild oat	-0.76	-0.21	0.13	0.38
Chickweed	-0.43	-0.07	-0.42	0.38
Speedwell	-0.52	-0.21	-0.41	0.38
Mayweed	-1.69	-1.24	-1.24	0.38
Mean	-0.77	-0.37	-0.36	--
LSD (P = 0.05)	0.38	0.38	0.38	--

Table 4: Mean crop equivalents of the weed species as affected by competition from four crops. Values are arithmetic means of three harvests

	Crop species				
Weed species	Bean	Wheat	Barley	Rape	Weed mean
Cleavers	0.11	0.11	0.09	0.27	0.15
Wild oat	0.07	0.10	0.05	0.23	0.11
Chickweed	0.03	0.17	0.08	0.24	0.13
Speedwell	0.03	0.12	0.04	0.18	0.09
Mayweed	0.004	0.02	0.005	0.009	0.009
Mean	0.05	0.10	0.05	0.19	0.10

LSD (5%): Weed means = 0.04, Crop means = 0.06,
Crop X weed = 0.09

Weed biomass: The shoot biomass of individual weed species were affected differently by competition with the crops (Table 2). Cleavers were least affected (57% reduction) and mayweed were affected most (99% reduction). The effects of crops on the weeds were also variable. The shoot biomass of weeds were most affected by barley (91% reduction) and least affected by rape (71%). A significant crop x weed interaction was also noticed.
The effect of competition on the weed species also varied in different growth stages. Although in general, the mean shoot biomass of weeds increased at mid growth stage (2nd harvest) and then decreased, there was an interaction between weed species and harvest dates. For example, the shoot biomass of cleavers and wild oats increased progressively up to final harvest but that of chickweeds and speedwells decreased after 2nd harvest (Table 3).

Crop equivalent (CE) of weeds: There were great differences between mean CEs of weed species (Table 4). The highest CE values were found for cleavers and chickweeds followed by wild oat and the lowest CE was for mayweed. The mean CE values of the weeds were also differed between crops. The highest CE was observed in oilseed rape followed by wheat and the lowest value was in bean. However, there was an interaction between weeds and crops. For example, although cleavers and wild oats were affected more by barley than rape, mayweed were equally affected by both crops.

Aggressivity (AGGR) of weeds: Weed species differed significantly ($P < 0.001$) in their aggressivity values. Cleavers were the most aggressive, even more competitive than crop species and mayweed were the least competitive species, although they did not differ significantly from chickweed and speedwells. The competitive ability of weeds was found to be crop specific (Table 5). In this study the cleavers were found to be more competitive in beans and rape. The weed being a vine type plant, was provided with climbing support by the crop plants specially by beans and rape, which favoured the weed in intercepting more light for better photosynthesis. Wilson (1986) also observed severe competitive ability of cleavers in wheat where even at low density it caused substantial yield loss. It is also clear that cleavers were 2.5 times more competitive than mayweed and wild oats were 2.0 times more competitive than mayweed. This suggests that the threshold values need to be calculated on the basis of their competitive abilities, not only on their total densities. The relative competitive ability of cleavers was greater than other species apparently due to its higher growth rate specially at later stage of growth and large plant size (Peters, 1984; Wilson and Wright, 1987).
A significant interaction between the weed species and harvest dates was also noticed in the experiment. For example, cleavers and wild oats were more competitive at later stages of growth and they were found to maintain their growth until final harvest (Table 6) indicating that these weeds are late competing species. Wilson and Wright (1990) also identified these weeds as late competing species. Chancellor (1976) suggested that wild oat may be suppressed by well-developed cereal crops at an early growth stage when it seems to be weak and susceptible to crop competition, but at a later stage it becomes a vigorous competitor due to prolific production of crown roots. In contrast, speedwell

Table 5: Aggressivity of weed species under four different crops. Values are arithmetic means of three harvests

	Crop species				Weed	LSD
Weed species	Bean	Wheat	Barley	Rape	mean	(P = 0.05)
Cleavers	0.99	-0.33	-0.66	0.42	0.11	0.20
Wild oat	0.11	-0.63	-0.68	0.03	-0.29	0.08
Chickweed	-0.69	-0.62	-0.78	-0.15	-0.56	0.11
Speedwell	-0.64	-0.59	-0.60	-0.21	-0.51	0.10
Mayweed	-0.58	-0.70	-0.70	-0.51	-0.63	0.10
Mean	-0.16	-0.57	-0.68	-0.08	--	--

Table 6: Mean aggressivity of the weed species at different harvest dates. Values are arithmetic means of four crops

	Harvest dates			Weed	LSD
Weed species	10 April	09 May	20 July	mean	(P = 0.05)
Cleavers	-0.20	-0.31	0.85	0.11	0.33
Wild oat	-0.37	-0.44	0.05	-0.29	0.33
Chickweed	-0.58	-0.44	-0.46	-0.56	0.33
Speedwell	-0.54	-0.56	-0.38	-0.51	0.33
Mayweed	-0.62	-0.56	-0.58	0.63	0.33
Mean	-0.46	-0.56	-0.10	--	--
LSD (P = 0.05)	0.33	0.33	0.33	--	--

Table 7: Seed yields (g m^{-2}) of the crops as affected by the competition from weed species

	Crop species				Weed	
Weed species	Bean	Wheat	Barley	Rape	mean	% loss
Cleavers	308	491	222	54	269	33.9
Wild oat	356	527	244	68	299	26.5
Chickweed	422	478	220	79	300	26.3
Speedwell	411	547	242	75	319	21.6
Mayweed	654	532	206	93	371	8.8
Crop mean	430	515	227	74	312	23.3
No weed mean	658	569	298	101	407.0	--

and chickweed usually die back before crop harvest particularly in winter crops which indicates that they are early competing species. Therefore, these species should be controlled early in the season. However, since in field conditions, mixed population of weed species usually occur and most of the species are generally early competing, adoption of early weed control measures is advisable.

Crop equivalent vs aggressivity: When crop equivalent and aggressivity were compared, a poor correlation between two measures was noted (r^2 = 0.01, n = 15). The ranking order of weeds based on CE and AGGR varied as follows - I) CE: cleavers > chickweed ≈ wild oat > speedwell ≈ mayweed, ii) aggressivity: cleavers > wild oat > chickweed ≈ speedwell > mayweed. Harper (1977) proclaimed that the behaviour of plants in mixtures can not be judged by the behaviour of pure stands. Aggressivity is a measure of competitive ability of plant species where both the effects of crop on weed and that of weed on crop are considered. Therefore, more accuracy in measuring the competitive ability of weeds could be achieved. Crop equivalent on the other hand, does not take account the effects of crop and weed on each other. The effect of weed species on the grain yield of the crops was also remarkable. The highest percent yield loss was recorded by cleavers (33.9%) and the least yield loss was caused by mayweed (8.8%) (Table 7). CE and aggressivity were also compared with percent loss of crop yields. Aggressivity of weed was found to positively correlated with yield loss (r^2 = 0.54, n = 5) whereas CE was not (r^2 = 0.03, n = 5).

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