

THE NATURE OF COMPETITION BETWEEN FORAGE HERBS, PERENNIAL RYEGRASS AND WHITE CLOVER UNDER ORGANIC FARMING CONDITIONS

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ABSTRACT

Chicory and ribwort were sown alone or with perennial ryegrass (PRG), PRG/white clover (WC) or WC at three seed rates (1, 5 and 20 kg/ha) in fields or in the glasshouse in the north-east of Scotland under organic farming conditions during 1995-96. PRG showed strong negative effects on root and shoot development of the herbs, but it increased total herbage production. WC had no marked effect on herb establishment when it was sown without PRG. Density dependent competition in herbs for different seed rates were higher during early establishment when plant count was high. Competition between companion species was higher during late establishment when herbs and companions were in their fast growing phase.

KEY WORDS

Chicory, ribwort, white clover, companion species, competition, organic farming, forage herbs

INTRODUCTION

Forage herbs are present to some extent in all pastures. In intensively managed pastures, they are mostly considered as occasional weeds. However, in extensively managed pastures they have been thought of more positively as deep-rooting mineral rich plants which can aerate the sub-soil through their long tap root system and can also bring minerals to above-ground parts of the plant, where they can enrich the upper layers of the soil and the pasture, which subsequently improves the diet of the grazing animals (Foster, 1988). The chemical analysis of herbs shows that most herbs have higher amounts of phosphorus, magnesium, potassium and sodium compared to PRG and WC (Swift et al., 1993). However, herbs are still not common components of seed mixtures, because the agronomic requirements for persistent and reliable herb-based pastures are not known. The aim of this paper is to determine the effect of seed rate and companion species on the establishment of chicory (*Cichorium intybus*) and ribwort (*Plantago lanceolata*) under organic farming conditions.

MATERIAL AND METHODS

In the present study, chicory and ribwort (local cultivars) were sown in the field and pots at Craibstone, Aberdeen, north-east Scotland under organic farming conditions. In two separate field trials (one for each herb), three seed rates (1, 5 and 20 kg/ha) of the herb were sown with either no companion species or with PRG cv *Merlinda* (10 kg/ha) or PRG/WC cv *Menna* (2 kg/ha) in 1.5 by 7.5 metre plots on 12.4.95. The soil was a sandy loam with pH 5.9 and organic matter of 11 per cent. The climate of the area is temperate and the mean temperature during early establishment was 9 C (May), but the minimum temperature remained below 0 C from 13th of May to 19th of May 1995. The germination of chicory and ribwort started on 8.5.95 and 11.5.95 respectively. Measurements were taken in June, July, September 1995 and April 1996. In the pot trials, herbs were sown with the same seed rates with PRG or WC only, in an unheated glasshouse in pots (600 cm²) filled with 10 litres general purpose compost, at a depth of 10 mm in August 1995. Measurements were taken in December 1995 and April 1996. The effects of companion species on herb height, root length, shoot and root dry matter (DM) and effects of herbs seed rate on companions species were measured on an individual plant and on a per unit area basis.

RESULTS AND DISCUSSION

In the field experiments, higher herb seed rates increased herb plant population and DM weight/m² significantly ($P < 0.001$) at all sampling dates, but there was a marked decrease in plant population, averaging 7 fold and 5 fold in chicory and ribwort treatments respectively, between June and September 1995. This was either the result of lower temperature or intraspecific competition during early establishment. Therefore, the higher seed rates had a significant negative effect on individual plant size only at the first observation. By September 1995, biomass in all treatments had increased substantially, and companion species had a greater negative effect on individual shoot weight, shoot weight/m² and weight of weeds/m² in both herb trials (Table 1), which decreased the contribution of herbs in the sward. However, treatments with companion species had the highest herbage biomass/m² on all observed dates. The effects of companions on root and shoot DM of individual herb plants were not significant in April 1996, because both herbs were almost dormant.

In the pot experiments, companions had no significant effect on mean root length, individual root and shoot DM weight and root and shoot/m² of ribwort on 5.12.95 (116 days after sowing) but it was highly significant on 1.4.96 (Table 2). The effect of seed rate also had a significant effect on individual root and shoot weight on 1.4.96. The root length and shoot weight per plant of ribwort was significantly decreased with PRG compared to the pure stand or with WC. Individual root weight was significantly higher in pure stand than with both companion species. The contribution of ribwort plants/m² (both shoots and roots) was significantly decreased with PRG compared to the pure stand or with WC. Similar patterns were observed with chicory but with larger variation in root and shoot growth, possibly as a result of genetic variability of the local cultivar. In both herbs, total herbage production/m² was significantly higher when grown with PRG than in pure stand or with WC. The companions had no significant effect on plant number/m² of both herbs.

CONCLUSION

The field experiments for chicory and ribwort suggest that early establishment of both herbs is more dependent on environmental factors and intraspecific competition than companion species, but later in the establishment phase, when herbs and companion species are growing fast, companions have a more significant negative effect on herbs than seed rates, although this negative effect would be limited during the dormant stage of either herbs or companion species. Total production per unit area was higher in herb plus PRG combinations, but PRG had a negative effect on establishment of both herbs; therefore, in the long term, PRG may also decrease the persistence and contribution of these herbs in the sward, whereas WC as a companion appears to be less competitive to the herbs and in the long term with its nitrogen fixing ability it may be an ideal companion species. However, the PRG/WC treatment showed a strong negative effect on herbs and the nitrogen fixed by WC was probably used by PRG which gave it more vigour for competition with herbs. In a temperate climate, under organic farming conditions, WC sown alone with herbs may check invasion of weeds and also provide a higher amount of nutritive herbage during the growing season.

REFERENCES

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Table 1

Effect of companion species on chicory and ribwort under field conditions (9.9.95).

Variables	Chicory				Ribwort			
	Nil ¹	PRG	PRG/WC	Sig ²	Nil	PRG	PRG/WC	Sig
Herb individual shoot DM weight(g)	2.86 ^a	1.66 ^b	1.35 ^b	**	4.46 ^a	3.12 ^{ab}	2.08 ^b	**
Herb Plant number/m ²	27.00 ^a	21.22 ^b	20.67 ^b	**	36.30 ^a	29.3 ^b	30.7 ^b	*
Herb shoot DM weight /m ² (g)	52.64 ^a	39.5 ^{ab}	29.33 ^b	*	130.1 ^a	89.8 ^b	73.1 ^b	**
Weeds shoot DM weight /m ² (g)	454.3 ^a	309.7 ^b	259.5 ^b	***	510.9 ^a	339.3 ^b	339.4 ^b	***
Sown species total shoot DM/m ² (g)	52.64 ^a	218.6 ^b	241.4 ^b	***	130.5 ^a	209.6 ^b	188.6 ^b	***

1. Nil (herb in pure stand), PRG (herb with perennial ryegrass) and WC (herb with white clover).
2. Statistical significance (ANOVA) is shown as * (P<0.05), ** (P<0.01), *** (P<0.001) and NS (P>0.05).
3. Means with different letters for each date in each row are significant (LSD) at P<0.05 or above.

Table 2

Effect of companion species on ribwort under glasshouse conditions on 5.12.95 and 1.4.96.

Variables	5.12.95				1.4.96			
	Nil	PRG	WC	Sig	Nil	PRG	WC	Sig
Mean root length (cm)	11.07	12.05	10.03	NS	38.22 ^a	18.78 ^b	33.85 ^a	***
Mean individual root DM weight (g)	0.038	0.052	0.038	NS	0.215 ^a	0.056 ^b	0.127 ^b	**
Mean individual shoot DM weight(g)	0.115	0.089	0.094	NS	0.580 ^a	0.147 ^b	0.454 ^a	***
Root DM weight/m ² (g)	7.11	6.93	7.67	NS	22.46 ^a	8.33 ^b	18.62 ^a	***
Shoot DM weight/m ² (g)	20.21	16.47	20.59	NS	67.2 ^a	28.82 ^b	53.4 ^a	***
Total below ground DM weight/m ² (g)	7.11 ^a	26.76 ^b	13.29 ^a	***	22.46 ^a	78.33 ^b	26.20 ^a	***
Total above ground DM weight/m ² (g)	20.21 ^a	57.65 ^b	29.57 ^a	***	67.2 ^a	143.5 ^b	78.23 ^a	***

1. Nil (herb in pure stand), PRG (herb with perennial ryegrass) and WC (herb with white clover).
2. Statistical significance (ANOVA) is shown as * (P<0.05), ** (P<0.01), *** (P<0.001) and NS (P>0.05).
3. Means with different letters for each date in each row are significant (LSD) at P<0.05 or above.