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Initial red clover (*Trifolium pratense*, L.) variety evaluation for soil fertility-building

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Introduction

Nitrogen fixation by legume crops within arable rotations can build soil-fertility, produce a home-grown, high-protein fodder and provide a suite of ecosystem services. Although red clover (*Trifolium pratense*, L.) is primarily associated with grassland livestock production in the UK, it can also improve the performance of subsequent crops when grown alone or in monoculture (Doel 2013, Moyo 2015). Appropriate variety and foliage management selection could optimize this improvement. The goal of this project is to evaluate six red clover varieties, under treatments of one and two cuts, for fertility-building capacity. The yield and quality of subsequent bioassay crops will be used to assess this capacity.

Materials and Methods

Red clover is gametophytically incompatible (De Vega *et al.* 2015). As this generates intra-species diversity, significant diversity is also expected in commercial varieties. Synthetic tetraploid varieties have also been created by breeders. The main classifications of red clover varieties are early/late flowering, diploid/tetraploid and erect/prostrate. Descriptions of the varieties for this field trial are given in Table 1.

Table 1. Selected Varieties Description

Variety	Flowering	Ploidy	Growth Habit	Company or Institution
Amos	Late	Tetraploid (4n)	Erect	DLF Trifolium (Denmark)
Astred	Early	Diploid (2n)	Prostrate	PGG Wrightson Seeds (Australia)
Claret	Early	Diploid (2n)	Erect	IBERS (UK)
Maro	Middle	Tetraploid (4n)	Erect	DLF Trifolium (Denmark)
Milvus	Early	Diploid (2n)	Erect	Agroscope (Switzerland)
Ruby	Early	Diploid (2n)	Erect	IBERS (UK)

The varieties were studied in monoculture on calcareous clay soil (Sherborne series), of pH 7.15, in Cirencester, UK. The site was located at 51° 71' N at latitude and 01^0 99'W longitude, at an altitude of 135m above sea level. The experimental design was completely randomized block with four replications, individual plots were $9m^2$. Treatments of 1 and 2 cuts were applied in July and October respectively. Air temperature and precipitation were comparable to the long-term average throughout the growing season. Cuts were undertaken at the early-bloom stage. Performance was documented using DM t ha^{-1} and kg N ha^{-1}. A nodulation assessment was carried out using the methodology of Rice et al (1977) following one year of growth. Susceptibility to powdery mildew (*Erysiphe* sp) and clover rot (*Sclerotinia* sp) according to Singh et al (2013) and Dixon and Doodson (1971) respectively. Results were analyzed using Genstat® v.15.

Results and Discussion

Table 2. Performance of Varieties

	First Cut		**Second Cut**		**Disease Susceptibility**	
	DM (t ha^{-1})	N (kg ha^{-1})	DM (t ha^{-1})	N (kg ha^{-1})	Powdery Mildew (%)[1]	Clover Rot (D.I.)[2]
Amos	0.75a	24.37ab	0.82c	30.06d	29.2bc	259a
Astred	0.56b	15.83c	1.58a	66.99a	25.63c	136d
Claret	0.60b	19.25bc	1.64a	63.29ab	26.11bc	225bc
Maro	0.85a	28.20a	1.51ab	57.19bc	32.17ab	214c
Milvus	0.49b	19.28bc	1.60a	61.5abc	26.18bc	245ab
Ruby	0.56b	19.15bc	1.35b	54.78c	37.29a	149d
SED	**0.06**	**3.32**	**0.11**	**4.79**	**2.07**	**9.40**

All results are subjected to ANOVA and LSD ($p>0.05$) to determine significance
[1] Scored according to Singh et al (2013). Percentages have been angularly transformed to reduce heterogenity of variance. Results subjected to ANOVA, low score = higher resistance to powdery mildew
[2] Disease Index. Scored according to Dixon and Doodon (1971). Results subjected to ANOVA, low score = higher resistance to clover rot

The late flowering tetraploids yielded significantly higher DM t ha^{-1} and N kg ha^{-1} in the first cut, but only the mid-flowering variety (Maro) maintained good growth until the second cut. Aboveground N yields were comparable to other research (Carlsson and Huss-Danell 2003, Doel 2013, Moyo 2015). All varieties were observed to have more than 20 pink nodules growing in the crown region of the roots. Although tetraploidy is predicted to increase disease resistance in red clover varieties (Boller *et al.* 2010, Vleugels *et al.* 2014), the tetraploids studied were not more resistant than the diploids.

Conclusions

Significant differences in biomass accumulation were observed in different red clover varieties. Red clover leys can accumulate up to 85kg N ha^{-1} in the aboveground biomass in the first year. Tetraploidy was not shown to increase disease resistance.

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References

Boller, B., Schubiger, F. X. and Koelliker, R. (2010) Red Clover. In, Boller, B., Posselt, U. K. and Veronesi, F. (eds.) *Fodder Crops and Amenity Grasses.* Vol. 5. Springer, 233 Spring Street, New York, Ny 10013, United States: 439-455

Carlsson, G. and Huss-Danell, K. (2003) Nitrogen fixation in perennial forage legumes in the field. *Plant and Soil*. 253(2): 353-372

De Vega, J. J., Ayling, S., Hegarty, M., Kudrna, D., Goicoechea, J. L., Ergon, A., Rognli, O. A., Jones, C., Swain, M., Geurts, R., Lang, C., Mayer, K. F. X., Rossner, S., Yates, S., Webb, K. J., Donnison, I. S., Oldroyd, G. E. D., Wing, R. A., Caccamo, M., Powell, W., Abberton, M. T. and Skot, L. (2015) Red clover (*Trifolium pratense* L.) draft genome provides a platform for trait improvement. *Scientific Reports*. 5: 10

Dixon, G. R. and Doodson, J. K. (1971) Assessment keys for some diseases of greens, fodder and herbage crops. *Journal of the National Institute of Agricultural Botany*. 12: 299-307

Doel, J. M. (2013) *Accumulation and recovery of nitrogen in mixed farming systems using legumes and other fertility-building crops.* Coventry University

Moyo, H., Davies, W.P., Cannon, N., Conway J. (2015) Influences of one-year red clover ley management on subsequent cereal crops. Biological Agriculture and Horticulture *http://dx.doi.org/10.1080/01448765.2014.1001792*.

Rice, W. A., Penney, D. C. and Nyborg, M. (1977) Effects of soil acidity on rhizobia numbers, nodulation and nitrogen-fixation by alfalfa and red-clover. *Canadian Journal of Soil Science*. 57(2): 197-203

Singh, A. K., Bhatt, B. P., Singh, K. M., Abhay, K., Manibhushan, Ujjawal, K., Naresh, C. and Bharati, R. C. (2013) Dynamics of powdery mildew (*Erysiphe trifolii*) disease of lentil influenced by sulphur and zinc nutrition. *Plant Pathology Journal (Faisalabad)*. 12(2): 71-77

Vleugels, T., Cnops, G. and Roldan-Ruiz, I. (2014) Improving seed yield in red clover through marker assisted parentage analysis. *Euphytica*. 200(2): 305-320