Lucerne for dryland farming systems in the Queensland subtropics

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ABSTRACT

The degraded fertility of cropping soils in the Queensland grain belt can be improved by using lucerne, either in short or longer-term rotations. Research in collaboration with NSW Agriculture to improve the adoption of lucerne in farming systems, includes breeding and commercialising better cultivars. Lucerne "probe sets", comprising cultivars, accessions and breeder lines, were sown at 5 sites in 1997 to measure their production and persistence and to set genetic ideotype targets for further breeding. Highly winter active lines were the most productive and there were some winter active lines that expressed strong persistence traits. The winter active benchmark cv. Trifecta has been clearly superseded but production by the highly winter active benchmark, cv. Sequel was exceeded by only cv. Rippa and Y9549. Breeding for higher winter activity is a priority for short-term rotation lucernes for the Queensland grain belt. For this, there is a strong existing germplasm base to combine with well-selected accessions.

KEY WORDS

Lucerne, breeding, "probe set", soil fertility, production, persistence.

INTRODUCTION

Lucerne has the capacity to improve the fertility of soils and improve grain crop yields and quality in the Queensland grain belt (4, 5). It also produces high quality forage that is used to finish prime lambs (1) and beef cattle. Although the implementation of lucerne in cropping enterprises is slow with only 30-40,000 ha sown, it is now being used increasingly within mixed farming systems. A collaborative, integrated program with NSW Agriculture aims to improve the adoption of lucerne in dryland farming systems in the northern grain belt. This program of RD&E includes plant improvement, agronomic studies, the development of information packages and promotional activities. Farmers have assisted in identifying and prioritising RD&E targets including three major targets for lucerne cultivar improvement. These are a non-bloating lucerne, a lucerne for short term rotations that grows and fixes nitrogen more quickly than current cultivars, and a long term, persistent lucerne for sowing with grass.

In addition to this empirical process, research was initiated in 1997 to identify target plant traits and environmental attributes for the breeding program. A "probe set" of 56 lucerne lines comprising breeder lines, lines introduced from other countries and commercial cultivars, was sown at 5 locations on cropping soils in southern inland Queensland. The name, "probe set" was adopted as the sets were comprised of lines that would react differently to, thus probe, the environmental variability at each site. These lines range in winter activity between classes 3-9 and possess a range of resistances to major pests and diseases. The soils included five cracking clays, a Darling Downs black earth (Kingsthorpe – 27.30 S., 151.50 E.), a grey brigalow clay (Warra – 26.49 S., 150.57 E.), a brown Mitchell grass clay (Roma – 26.43 S., 148.36 E.), and a grey Coolabah clay (Nindigully – 28.27 S., 148.50 E.); and one loamy soil, a red duplex soil (Roma – 26.43 S., 148.50 E.). The plots were sown by drilling into 5 x 1.3 m plots in a spatial design with 3 reps, with four control cultivars duplicated to better assess random variation during data analysis. Yield assessments have been based on a cutting without grazing. Individual yield measurements have been made from mower strips in every plot at regular growth intervals. Persistence has been measured as a density index, developed by measuring gaps between plants in each row at intervals of 6-12 months. The same strips and rows have been used for each measurement.

Measurements from each site have been analysed using the spatial analysis program REML in the GENSTAT statistical analysis package. These sowings in Queensland link with a large number of equivalent sowings in New South Wales. When the data sets are complete, a G x E analysis will be conducted and a multivariate analysis in which production, persistence, chemical and physical soil attributes, climatic variables and known attributes of the probe set lines will be included. For this paper, the relationship between the mean total production and stand density for all sites in March 2000 is presented. General conclusions about the performance of cultivars and lines from different winter activity categories, and the implications of this for the breeding program and current cultivar usage, will be made.

RESULTS

Superior lines from the probe set evaluations are in Figure 1 and Table 1. The relative performance of lines for production and persistence in Table 1 are based on the relative values in Figure 1.

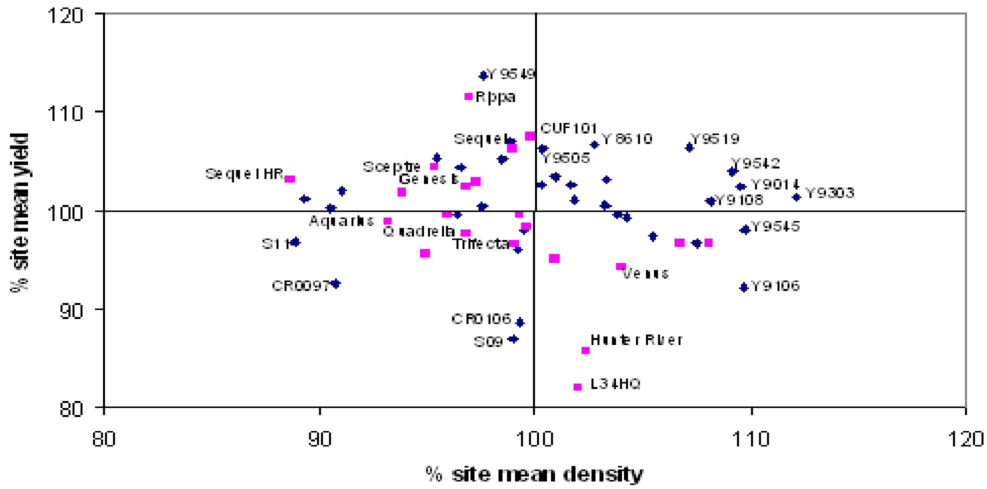

Figure 1. Relationship between the % site mean yield and plant density of lucerne lines at March 2000, averaged over five sites.

Winter active and highly winter active lines produced the highest dry matter production across all sites (Figure 1, Table 1). In particular, Y9549 and Rippa were highly productive and moderately persistent. Winter dormant cultivars *eg*. L34HQ were the least productive. Despite the broader crown base of these dormant lines, some of the winter active and highly winter active lines have been more persistent (data not presented). There are a number of promising “Y” lines from the NSW Agriculture breeding program that has preceded the current program that aims to develop new lucernes for dryland farming systems. These are clearly superior to all cultivars with the possible exceptions of Rippa and Sequel. Cultivars Hunter River and its successor Trifecta have now been, or have the potential to be, superseded in dryland farming systems by far more productive and persistent cultivars. It is notable that lines that demonstrated poor production and persistence *viz*. S09, S11, CR0097 and CR0106, are accessions and not “Y” lines. Substantial advances have thus already been made in germplasm from the preceding breeding program.

Table 1. Relative dry matter production and persistence (maximum = 10, minimum = 1) of the best performing lucerne lines in the probe set at March 2000, averaged across all sites. Lines with activity classes 6-7 are winter active, and with activity classes 8-10 are highly winter active.

Line	Activity Class	Production	Persistence
Y 9549	8	10	4

Rippa	10	9	4
Y 9519	8	8	8
Y 8610	7	8	6
Y 9505	8	8	5
CUF 101	9	8	5
S 20	7	8	4
Sequel	9	8	4
Y 9542	7	7	9
Y 9303	8	6	10
Y 9108	6	6	8
Y 9014	7	6	9
Y 9545	7	5	9

[1] Y lines from NSW Agriculture breeding program (R. W. Williams, *pers. comm*.)

Among the best performing lines (Table 1), Rippa and Y9549 have been productive and Y9014 and Y9545 persistent, at more than one site. Lines other than in those in Table 1 have performed well at the five evaluation sites (Table 2) including Y9103, which has been uniquely the most productive line on the Mitchell grass clay soil.

Table 2. The superior lines of lucerne at five evaluation sites.

Evaluation site	**Most productive lines**	**Most persistent lines**
Roma red loam	CRO205, Rippa, Eureka	Y9014, Y9106, Venus
Warra grey clay	Y9549, Rippa	PL69, S20, Y9303
Somerset brown clay	Y9103	Y9545

Nindigully grey clay	S23, Y9549	Y9545, Y9014
Kingsthorpe black earth	Rippa, Y9549, S24	Y9108, Aurora

DISCUSSION

High production by lucerne in the short term (2-3 years) in these evaluations has been related to high winter activity. This contrasts with the correlation between high productivity and resistance to root rot (PRR, caused by *Phytophthora medicaginis*) and crown rot (CCR, caused by *Colletotrichum trifolii)* as well as with winter activity, identified by Gramshaw *et al*. (3) in wetter and more humid environments in the subtropics. New lucernes selected for short-term rotations in dryland farming systems in Queensland may not need the same high level of resistance to the major diseases, particularly crown rot, as in more humid environments. Breeding for better production (and by implication, N fixation) in the semi-arid environment of dryland farming systems seems a greater priority. Nevertheless, there is some need for adaptive qualities relating to disease resistance, particularly PRR.

Lucerne aphids occur sporadically in evaluations in which most lines and cultivars are at least moderately resistant. Two severe infestations of spotted alfalfa aphid severely reduced the productivity of susceptible lines, particularly Hunter River, at two evaluation sites (data unpublished). This highlights the need to maintain at least moderate levels of resistance to lucerne aphids. The breeding target of a long-term lucerne with combined resistance to grazing and the disease syndrome that result in stand thinning, and with the ability to compete with grass, is not met in this study. Nor is the issue of non-bloating lucerne, an unlikely product of breeding programs currently in Australia. Nevertheless, a number of lines have been moderately productive but very persistent and may provide a basis for developing cultivars for longer term pasture phases. Although no G x E analysis has yet been carried out, superior lines vary with environment in Queensland. The differences in performance of lines and cultivars between regions emphasise the need for wide field evaluation and the release of varieties suited to different environments.

CONCLUSIONS

Highly winter active cultivars and lines with moderate to good persistence have been the most productive during the first three years of the evaluation of lucerne “probe” sets in the Queensland subtropics. In the future, breeding new lucernes for use in short-term rotations needs to be directed towards producing more highly winter active cultivars with some adaptive attributes relating to disease and lucerne aphid resistance. There is germplasm in the program that can contribute to this need. There is also germplasm in the program that has the potential to further improve the persistence of current lucerne cultivars.

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