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Selection for redlegged earth mite resistance in annual *Medicago* species

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Summary

Since the last workshop, screening of the annual medic collection contained in the Australian Medicago Genetic Resources Centre has continued. Over 2000 lines have been screened in this period, and in general the relative results for species have broadly paralleled those obtained prior to the 1991 season. However, there have been some very encouraging new resistance sources discovered within *Medicago murex* in particular. Some crosses between cotyledon resistant and susceptible types produced during this period were screened for resistance segregation at the F_2 stage. However, at this stage there was no clear delineation evident between types, suggesting that resistance, in these cases at least, is either genetically complex and/or insufficiently strong to give adequate field protection. These crosses will be grown on to the F_5 or F_6 stage to allow further segregation and then rescreened, while a range of other crosses will be produced to test parental potential as resistance sources.

Introduction

Redlegged earth mite (*Halotydeus destructor* (Tucker)) is a significant pest to Australian agriculture, and in particular to annual legume pastures including annual medics. This was widely reported on at a workshop held in Perth in 1991 (Ridsell-Smith 1991).

Annual medics are a very valuable part of these legume pastures across wide areas of southern Australia. They are particularly vital in ley farming systems where pastures based on annual medics are rotated with cereal crops. In this system, the medic produces direct economic return through its high quality as a stock feed, and also indirectly via its nitrogen fixation, leading to higher yields of higher quality cereal in subsequent years (Cocks *et al.* 1980, Crawford *et al.* 1989).

Pest resistance is one of the major breeding and selection criteria for annual medics developed through the National Annual Medic Improvement Program. Success in breeding and selecting cultivars with good resistance to several aphid pests (Crawford *et al.* 1989) has spawned interest in the possibility of breeding new cultivars which also incorporate resistance to redlegged earth mite.

Possible resistance sources have been reported upon (Gillespie 1991, Lake 1991), although these have not been found in all annual medic species of commercial interest. Nevertheless, preliminary screening results indicated that selection for medic resistance to this pest may be achievable.

Methods

A more detailed description of the screening process has been described (Lake 1991), however the main points with some minor changes are summarized below:

High populations of redlegged earth mite are encouraged in the field by the sowing of strips of culture crops such as Languedoc vetch and Clare sub clover at one to two-month intervals from March to August. If necessary these can be supplemented by redlegged earth mite collected off-site. This enables screening to take place between May and October before mite numbers begin to decline.

Plastic flats containing rows (20 seeds) of up to 16 lines and three check varieties or controls are germinated in a glasshouse prior to being transferred to the field at the early post-emergence stage (5-7 days post sowing). The controls currently used are Beenong (*Trifolium cherleri*), Jemalong (*M. truncatula*) and Z-239 (*M. littoralis*), representing moderate resistance/tolerance, slight resistance/tolerance and susceptibility, respectively.

A score for cotyledon damage is carried out when there is clear differentiation between the control varieties, usually 4–7 days after transfer to the field. A second score for cotyledon damage is carried out a week later, followed by two scores for leaf damage at approximately weekly intervals.

Scores are based on a scale of 1–10 according to degree of cotyledon and leaf silvering, dwarfing and distortion with '1' representing undamaged plant tissue and '10' very severe damage likely to cause plant death. Scores are corrected as far as possible to take account of the controls which are nominally rated at 2 (Beenong), 5 (Jemalong) and 9 (Z-239).

The selection of lines from the Australian Medicago Genetic Resource Centre is partly based on the desire to screen a broad spectrum of species and accessions and partly on previous results indicating potential geographical sources of resistance. In addition, the better lines from

previous screenings are re-screened in order to check technique and stability of results.

As well as the above accessions from the Australian Medicago Genetic Resource Centre, hybrids have been produced from crosses by the National Annual Medic Improvement Program between susceptible parents and some of the more cotyledon resistant lines of *M. polymorpha* and *M. truncatula*. These were screened at the F_2 stage in 1993.

Table 1. Summary of redlegged earth mite screening results (1991–93) showing range and average damage score (1–10).

Species	Number tested	Cotyledon damage score			Leaf damage score		
		low	high	average	low	high	average
M. aculeata	25	2.5	7.0	5.27	3.0	7.75	4.49
M. littoralis	31	4.75	8.5	6.12	3.0	8.25	4.93
M. murex	223	1.75	8.75	4.46	2.75	8.25	4.90
M. polymorpha	1156	2.25	9.0	4.83	2.75	8.25	5.78
M. truncatula	603	3.0	9.0	5.64	2.75	8.0	4.67
Other spp.	33	2.75	8.0	3.25	7.75		

Results and discussion

Since the report in the last workshop, a further 2071 lines of various species of annual medic have been screened (to end of 1993) by the National Annual Medic Improvement Program, the performance of which is summarized in Table 1. This shows the range of scores and the overall average recorded for both cotyledon and leaf damage for each of the species listed.

A tendency for scoring to become more rigorous with time has been noted. This is possibly due in part to the increased number of lines with higher resistance that are coming through the system as a result of improved targeting. This has meant that the better lines from the earlier (pre-1991) screenings have had to be rated slightly higher (i.e. worse) when re-screened to allow room for lines with better resistance to fit on the scale. In addition, the scoring has become more demanding with respect to what actually constitutes useful field resistance. A similar drift in scoring was also noted by the principal author in the early days of aphid screening.

Despite the increased rigour of scoring, the average scores for both cotyledon and leaf damage of most of the above species have actually declined from those published in 1991, perhaps again indicating the effect of a more focussed selection of lines to be screened with respect to geographical origin of collection.

There are obvious differences between species in terms of cotyledon resistance and although there is some variation in the scores relative to the earlier work (pre-1991), the relative performance of species has basically remained the same except that *Medicago murex* has overtaken *M. polymorpha* in terms of average resistance.

The average damage scores for leaves for the different species also follows the same general pattern as before, often less than those for cotyledon damage. The exceptions to this were *M. polymorpha* in which the situation was reversed (as it was when previously reported) and *M. murex* which was one of the few species where scores showed an increase on the previous results.

The degree to which leaf and cotyledon scores are correlated does not appear to be very great which is consistent with the earlier findings which indicated that selection for low redlegged earth mite damage at the cotyledon stage does not necessarily result in a plant with similar resistance in the vegetative stage of growth or vice versa.

Several promising new sources of resistance were found, particularly at the cotyledon stage and particularly in *M. murex*. Another point of interest is that a number of the most resistant lines of *M. polymorpha* and *M. murex* originate from south-eastern Europe (e.g. Greece, Italy, Sicily and Sardinia).

Some test crosses have been made between the most resistant lines and susceptible lines in order to screen the F_2 hybrids for segregation and thus attempt to identify parents with high resistance heritability. However, at this stage there has been no clear delineation of resistant and susceptible types in any of the crosses and hence these hybrid populations will be grown on to the F_5 or F_6 stage to stabilize them, and then re-screened and progeny tested to see whether good levels of resistance can be recovered. This process will be continued with superior lines as they are identified through the initial screening process.

In the future, crosses will be made between lines with best resistance in an attempt to incorporate different resistance genes into the one plant and also to endeavour to achieve some additive effects upon the level of expressed resistance.

Medics are also very susceptible to redlegged earth mite damage at flowering (Gillespie 1995, Hopkins 1995), particularly with respect to seed yield. Further study is required to ascertain what resistance medics have to redlegged earth mite at flowering and whether there is any correlation to seedling resistance.

Future directions

It is anticipated that future screening for redlegged earth mite resistance in annual *Medicago* species will be carried out as outlined above for the term of the current the National Annual Medic Improvement Program project (DAS 62F, 1 July 1992–30 June 1997). Test crosses will continue to be made in an attempt to locate parents with high resistance heritability and crosses between superior parents will be performed, in an endeavour to increase current levels of expressed resistance through additive effects of multiple gene resistance.

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