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TEMPERATURE EFFECTS ON GERMINATION OF 'GRASSLANDS MAKU' LOTUS AND OTHER EXPERIMENTAL LOTUS SELECTIONS

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Abstract

The germmation rate of 'Grasslands Maku' lotus *(Lotus pedunculatus* Cav. syn *L uliginosus)* was assessed at constant temperatures of 20°, 15°, 10" and a fluctuating temperature of 5°/10°C (16 h/8 h per day). Germination rate declined with temperature. Maximum germmation level was reached by 2 weeks at 20°C and 15°C. but at 10°C only 30% of seeds, and at 5°/10°C only 1% had germinated by this stage.

Large seeds of Maku germinated faster than small seeds. Seedlot thousand seed weights of *Maku* lotus parent plants varied from 0.78 to 0.96 g and germmation rates of these lots at 5°/10°C were associated with seed size.

Maku and 4 other lotus selections had much lower germination rates than two Lotus *corniculatus* cultivars and an interspecific hybrid selection G.4712. G.4702 (another tetraploid) germinated more rapidly than other lotus selections and Maku. These results indicate the need for production of quality Maku *lotus* seed, especially in terms of seed size, and for selection to improve germination rate.

Keywords: Maku lotus, germination, temperature

INTRODUCTION

The germination capacity and rate of a range of herbage grasses (13 cultivars) and legumes (14 cultivars) over a range of temperatures (530°C) has been studied and reported (Charlton *et al.* 1986; Hampton et *al.* 1987). The germination rate of some species was notably slow, especially that of tall fescue and cocksfoot among the grasses and lotus among the legumes.

The establishment phase is the most critical stage of a pasture's life, as the result largely determines subsequent performance (Sears 1961). Establishment failure with 'Grasslands Maku' lotus *(Lotus pedunculatus* Cav. syn *L. uliginosus)* has been common in New Zealand and elsewhere (Charlton unpublished). Its very slow germination rate of establishment over the first and even second years after sowing has been studied (Brock & Charlton 1978; Charlton & Brock 1980; Scott & Mills 1981). The slow germination rate of Maku at low temperatures (5/10°C) was reported (Charlton 1977) and has since been further studied.

Certified herbage seed is sampled and tested for purity and for germination capacity under standardised, controlled laboratory conditions (Scott et *al.* 1984). These laboratory conditions for germination are set so that seed of each species is given every chance to germinate to its full potential. However, these conditions usually differ from those in the field. The germination and establishment of seeds of pasture species depend on ambient temperature and the genotypic features of the seed, given that water and plant nutrients are non-limiting.

This paper reports results of studies carried out under controlled conditions at the Seed Testing Station, MAFQUAL, Palmerston North in collaboration with MAF scientists.

MATERIALS AND METHODS

Sampling and testing procedures followed those laid down by international agreement (ISTA 1985). The germination capacity and rate of Maku lotus was determined at constant temperatures of 20°, 15°, 10° and a fluctuating temperature of 5°/10° (16 h/8 h per day). Up to 4 seedlots were tested in a randomised complete block design which included 3 replicates of 100 seeds for each seedlot. Normal seedlings (ISTA 1985) were counted and removed during the experimental period (24 days).

In a separate study to examine effect of seed size on germination rate, larger and smaller seeds were separated from standard seedlots using graduated sieves and then germinated at a constant temperature of 10°C only, after determination of thousand seed weight (the standard measure for seed size), for comparison with the original seedlots.

A separate examination of 11 parent seedlots of Maku lotus in terms of germination rate at the 5/10°C fluctuating temperature range, was made over a period of 50 days. Finally, germination rate of Maku lotus was compared with those of 4 experimental selections of another perennial lotus, *L. corniculatus* L. (Canadian bred cultivars Leo and Maitland), and an interspecific hybrid between *L. corniculatus* and *L. pedunculatus* developed at Grasslands Division (G.47 12). This

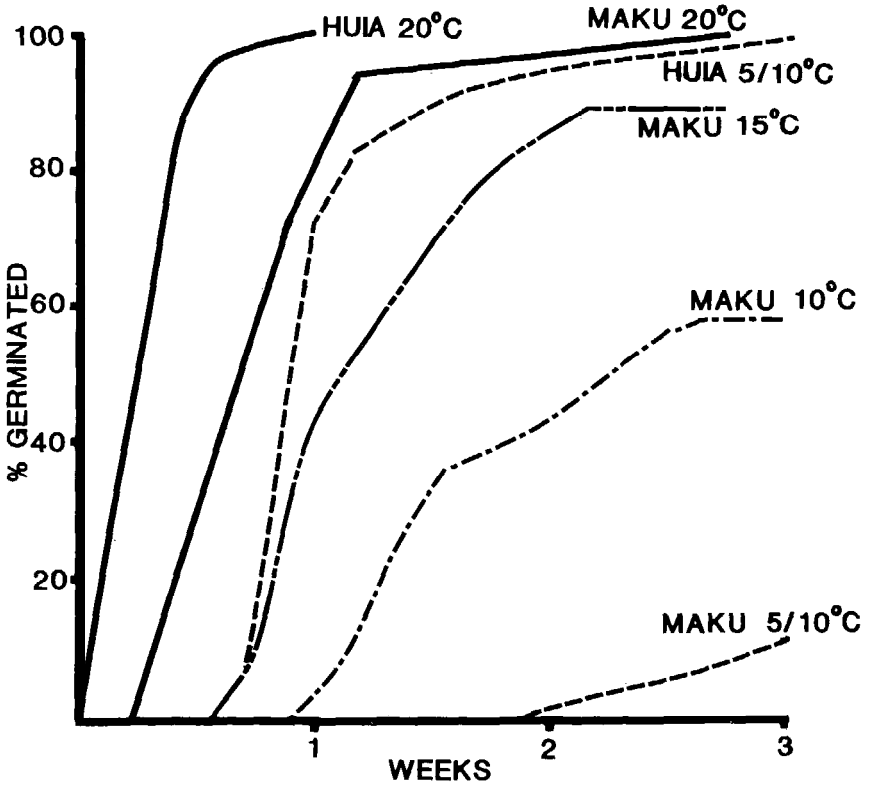

Figure 1. Relative mean rates of germination of Maku lotus at 20°, 15°, 10° and 5/10°C (16 h/8h), compared with those of Huia white clover at 20° and 5/10°C.

final germination rate study was carried out over 80 days, again under constant controlled conditions at 5°/10°C. Germination comparisons were made on values adjusted for germination capacity, and are calculated from the viable seed portion only from within each seedlot.

RESULTS

Grasslands Maku lotus

The germination rate of Maku lotus seed declined markedly as temperature decreased (Fig. 1). After one week at 20°C, 80% of Maku seeds had germinated, but at 15°C only 45% and at 10°C only 8% had germinated. At 2 weeks, maximum germination capacity had been almost reached at 15°C, but at 10°C only 43% of seeds had germinated, and at the 5°/10°C level only 1% of seeds had germinated.

Seed size significantly affected germination rate of Maku lotus grown at 10°C (Fig. 2). Though all seedlots were slow and had hardly started to grow at one week, after 2 weeks over 80% of large seeds had germinated whereas only half the small seeds were germinated. At 3 weeks, germination of all seedlots was completed, with a 30% difference between large and small seed categories.

The parent seedlines of Maku lotus showed a wide range of germination rate at 5°/10°C. The most vigorous line, ST267, had 65% germination at 2 weeks,

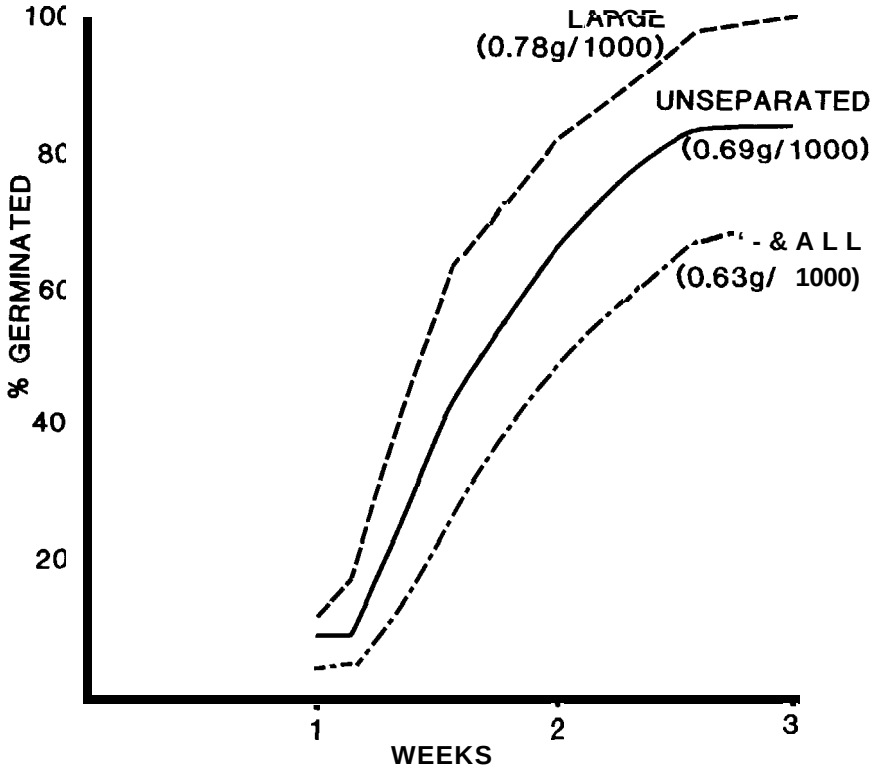

Figure 2. Relative germination rates at 10°C of larger and smaller seeds of Maku lotus separated from a standard seedlot.

contrasting sharply with the slowest lines, ST276 and ST269, with under 20% seeds germinated at this stage. After one month, most parents had reached 75-80% germination, but ST274 had 66% and the slowest lines were at 45%.

Relative performance of the. parent lines during germination under low temperatures appeared to be associated with seed size (r=0.94). Seedlines with lower thousand seed weights (0.80 g/1000 seeds) tended to have lower germination levels at 2 weeks after sowing. However, one parent line was exceptionally slow to germinate despite having the largest seeds.

Comparison with other Lotus material

Lotus *corniculatus* and the interspecific hybrid G.4712 germinated more rapidly than *L. pedunculatus* at low temperatures of 5°/10°C (Fig. 3). The former seedlots were at or above 75% germination, whereas *L. pedunculatus* lines were below 25% at 2 weeks after sowing. After 4 weeks, the tetraploid selection G.4702 had nearly 40% germination whereas the germination of Maku, also a tetraploid, was only 14%. G.4702, a diploid selection based on New Zealand lotus material, was similar to Maku in having slow germination during the first month but then germinated more rapidly than Maku during the second month. At this temperature, final emergence of G.4702 was 55%, whereas the other selections remained at 40%, because of hard seed and dead seed content.

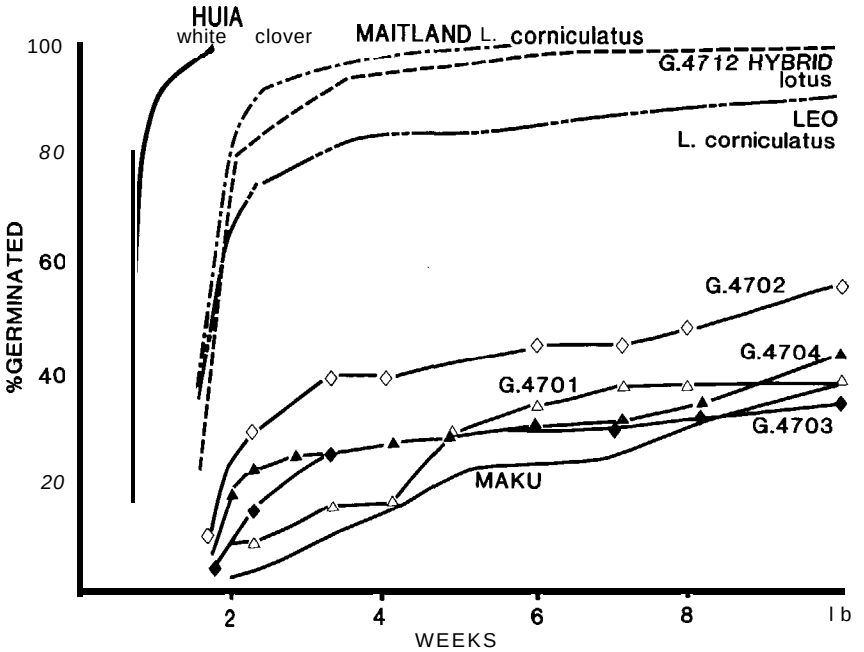

Figure 3. Germination rates of Maku and other lotus selections, 2 *L corniculatus* cultvars and G.4712 (*L. corniculatus* x *L pedunculatus*) hybrid, at 5°/10°C.

DISCUSSION

These comparative studies indicate that the germination rate of Maku lotus at low temperatures can be variable, and could be improved by selection of more rapidly germinating genotypes and also by production of larger seeded material

which is usually more vigorous. The objective of developing tetraploid selections of Lotus *pedunculatus* was to increase seed size and thus germination/establishment rate (Barclay 1958; Barclay & Lambert 1970). Seed produced in early multiplications of Maku lotus had thousand seed weights of around 0.90 g but often commercial seedlots average less than this, usually around 0.70 g/1000 seeds (A Johnson, MAF Seed Testing Station pers. comm.). Production of larger-seeded Maku in commercial quanitities should therefore be regarded as a major requirement

Time of sowing is another factor more critical for Maku lotus. In South Island, spring sowing would be preferable, enabling Maku seed to germinate in soils with rising temperature. North Island sowings, more usually done during autumn, should be carried out in early March if possible, when soil temperatures are still relatively high (White 1973).

Since the early studies indicated low germination rates in Maku lotus at low temperatures, some selection for more rapid selection within Maku has been done, by growing on seedlings that germinated early in laboratory tests. Two such selections have been evaluated under field conditions at Central Otago sites (Keoghan & Burgess 1987) and have performed better than Maku lotus. Such improvements should be applied to other slower-growing herbage species, particularly tall fescue and cocksfoot, and attention should be given to this characteristic in future plant breeding programmes.

Acknowledgements

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