Research Note

Relationship Between Seed Quality Tests and Field Emergence for *Lotus pedunculatus* (Cav.), *L. corniculatus* (L.) and *L. tenuis* (Willd).

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ABSTRACT

Test results from laboratory methods for assessing seed quality were compared with seed emergence in the field using single seed lots of *Lotus pedunculatus* (three cultivars), *Lotus corniculatus* and *Lotus tenuis*. Laboratory germination and bulk conductivity did not predict field emergence for a spring sowing, accounting for only 20% and 17% of the variability, respectively. Thousand seed weight and seedling fresh weight accounted for 70% and 56% of the variability in field emergence, respectively. Further research is necessary to identify factors which contribute to poor seed vigour and hence poor field emergence.

Additional index words: **bulk conductivity, germination, seed weight, spring sowing, seed vigour.**

EXPERIMENTAL AND DISCUSSION

Seed germination is the first step in field establishment of a crop. Laboratory germination following prescribed procedures (e.g. ISTA, 1993) is used worldwide to give an indication of seed quality and the likelihood of achieving field emergence. However, laboratory germination is not always a good predictor of field emergence and establishment (Hampton, Charlton, Bell and Scott, 1987). Laboratory germination tests are conducted under controlled, ideal conditions, designed to give maximum opportunity for seed lot performance; conditions in the field are rarely ideal. Seed vigour, defined as the sum total of those properties of the seed which determine the potential activity and performance of the seed or seed lot during germination and seedling emergence (Perry, 1981), is considered to be of importance in achieving rapid, uniform and high field emergence (Hampton and Coolbear, 1990), although it is not routinely measured by official seed testing stations.

Seed vigour in lotus can be measured using the bulk conductivity test (Hampton, Lungwangwa and Hill, 1994); that is, measuring the conductivity of water in which seed has been soaked. This test is not used routinely for lotus by the seed industry because of the cost involved; also, there is resistance to the introduction of further regulations in seed production, even though they might provide safeguards for the industry. The aim of this research was to determine relationships between laboratory germination (interim and final), field emergence and two methods of assessing seed vigour (bulk conductivity test and seedling weight) for *Lotus pedunculatus* (three cultivars), *L. corniculatus* and *L. tenuis*, to determine which of the laboratory methods gave the best prediction of field performance.

The *Lotus* species and cultivars used in this experiment were: Grasslands Goldie (*Lotus corniculatus* L.); Grasslands Maku (*Lotus pedunculatus* (Cav.), syn *L. uliginosus* Schkuhr); Grasslands Sunrise (*Lotus pedunculatus*); Grasslands 4704 (*Lotus pedunculatus*) and *Lotus tenuis* Willd.

Lotus seeds harvested on 4th February 1994 at AgResearch Lincoln were mechanically scarified in October using coarse sandpaper for 5 seconds (Baird, pers. comm.) prior to all measurements. Thousand seed weight (TSW) and seed moisture (1 h at 130°C) were measured on four replicates of 50 seeds for each species and cultivar. Results were analysed using MINITAB and SAS. SigmaPlot was used to derive regression equations.

For laboratory germination, four replicates of 50 seeds each for each species and cultivar were prechilled at 5°C for four days, then germinated on top of pre-moistened (10 ml distilled water) Whatman paper in petri dishes at a constant temperature (20°C) in darkness. Germination counts of normal seedlings were made at four and 12 days according to internationally agreed methodology (ISTA, 1993). Seedlings were carefully removed from the paper on day 12 and weighed.

The bulk conductivity test (Hampton *et al.*, 1994) was done in December 1994 and involved 16 weighed replicates of 50 seeds for each species and cultivar, soaking in 250ml deionised water for 24h at 20°C. Conductivity was measured using a Radiometer CDM2e with CDC 104 conductivity probe standardised using 0.01 M potassium chloride.

For field emergence, unchilled seeds were planted at 4mm depth in a Wakanui silt loam in the first week of October 1994, at 20mm intervals along a one metre row (i.e. 50 seeds per row). Plots were arranged in a randomised block design, with four replicates and five treatments. Each block contained five rows (plots) one metre long. Emergence was recorded 19 days after sowing (after which time no further increases in emergence were recorded). The soil was kept moist; soil temperature averaged 10.7°C at 100mm.

Thousand seed weight, interim germination and

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Table 1. Seed quality parameters and field emergence for the five *Lotus* sed lots.

Seed lot	TSW (g)	Interim count (%)	Final count (%)	Individual seedling fresh weight (g)	Conductivity (µs cm⁻¹g⁻¹)	Field emergence (%)
Maku (*L. pedunculatus*)	0.79	96	98B[1]	0.0118 A	99.2 BC	59.0 BC
G4704 (*L. pedunculatus*)	0.54	95	95B	0.0104 A	116.4 C	47.0 BA
Sunrise (*L. pedunculatus*)	0.56	92	96B	0.0090 A	84.0 B	34.0 A
Goldie (*L. corniculatus*)	1.10	73	82A	0.0241 B	176.7 D	75.0 D
Tenuis (*L. tenuis*)	1.26	96	96B	0.0209 B	61.5 A	68.0 CD

1 *For comparisons within a given column, data without a common letter are significantly different at P<0.01.*

final germination, plus vigour parameters, are presented in Table 1. Thousand seed weight varied according to species; *Lotus pedunculatus* seed was lighter than that of *L. corniculatus* and *L. tenuis*. Seed moisture averaged 6.05% (±0.6%).

Germination did not differ for the *L. pedunculatus* and *L. tenuis* seed lots, but was significantly lower for cv. Grasslands Goldie, (*L. corniculatus*) at both the interim and final counts, due to unimbibed (hard) seeds, not abnormal seedlings (Table 1). The difference observed between the interim and final count for all treatments was not significant (P<0.10).

Individual fresh seedling weights for *L. pedunculatus* cultivars were significantly (P<0.01) lower than for either *L. corniculatus* or *L. tenuis* (Table 1). There were significant differences (P<0.01) between the bulk conductivities of the three species, with *L. corniculatus* having the highest conductivity and *L. tenuis* the lowest (Table 1).

Field emergence appeared to be significantly (P<0.01) affected by species (Table 1) as *L. corniculatus* had the highest emergence and *L. pedunculatus* had the lowest. This may have been due to the soil temperature during the trial; *L. pedunculatus* is more sensitive to low temperatures than *L. corniculatus* (Charlton, 1989).

Data for field emergence were regressed against seed lot quality parameters. Laboratory germination (either interim or final count) was not a good indicator of field emergence, accounting for only 20% of the variability. In contrast, individual fresh seedling weight accounted for 56% of the variability (Fig. 1) and TSW accounted for 88% of the variability (Fig. 2). Field emergence was very poorly related to bulk conductivity (only 17% of the variability). In contrast, laboratory germination was related to bulk conductivity (48% of the variability). Laboratory germination was not related to

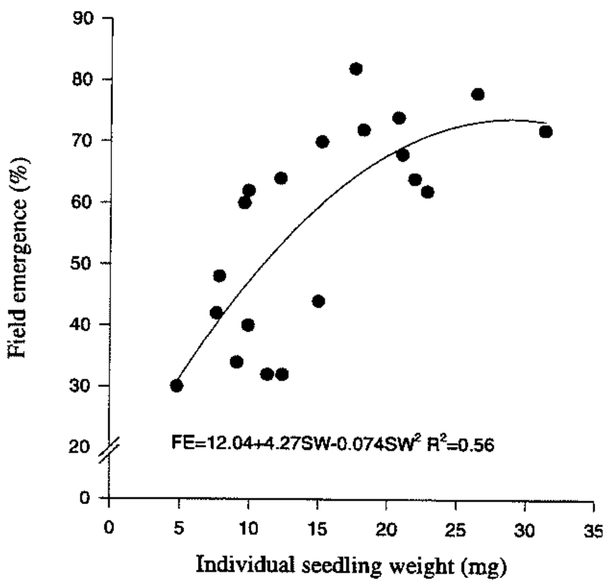

Fig. 1 Relationship between field emergence (%) and individual seedling fresh weight (g).

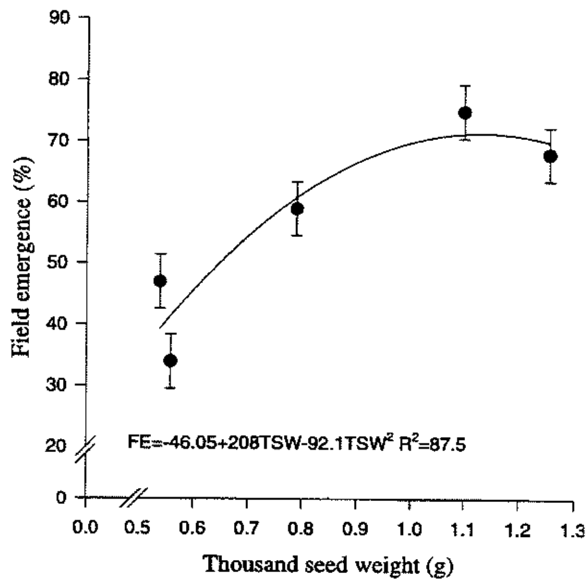

Fig. 2. Relationship between field emergence (%) and thousand seed weight (g). (Error bars indicate standard errors of the means; n=4; df errors = 15).

TSW (16%) but TSW was the primary factor affecting fresh seedling weight (85%).

The data gathered in this research support the statement by Hampton *et al.* (1987) that laboratory germination does not reflect field emergence. However, the bulk conductivity vigour test for *Lotus* spp. did not improve the prediction. Earlier studies with cv. Grasslands Maku (Charlton, 1989) indicated a positive relationship between field emergence and TSW; results from the present study support the suggestion (Charlton 1989) that larger seeds of lotus are more vigorous. This could be because they have larger endosperms, and hence reserves, to support a seedling during the time of establishment. These reserves are metabolised to produce larger seedlings which are likely to be better able to withstand non-ideal environmental conditions, thereby resulting in improved establishment. However, it is acknowledged that when seed lots of different cultivars are compared, the different TSWs might obscure vigour effects. When seed lots of the same cultivar are compared, vigour has been shown to be more important than TSW (Wang and Hampton, 1991).

The relationship between field emergence and TSW was apparent within a species (i.e. for the three *L. pedunculatus* cultivars), and also between the three lotus species. However, all the lotus seed used in this trial had been grown under the same environmental conditions and had been hand-harvested. Thus there were no differences in nutrition (which might have affected membrane integrity and/or endosperm reserves), harvesting (which could have caused physical damage) or post-harvest conditions (which could affect enzyme activity). Under non-experimental conditions, TSW is less likely to provide an adequate indication of field emergence as it does not take in to account any biochemical or physiological processes, or physical damage; the over-riding effect of vigour has been shown by Wang and Hampton (1991). In contrast, seedling fresh weight reflects not only TSW but also biochemical and physiological processes. Furthermore, it is relatively simple (and therefore cheap) to measure in the course of a routine germination test. In this experiment seedling fresh weight accounted for 56% of the variability in field emergence. While modellers regard 50% as a good start (A. Metherell, pers. comm.), other factors should be identified and included in the relationship to improve prediction of field emergence.

Export and sale of seed lots is becoming increasingly difficult as purchasers develop increasingly stringent requirements. Regulations protect purchasers from buying poor seed; standards which are difficult to meet act as barriers to importation. Seedling weight and bulk conductivity are plainly not the whole answer in estimation of *Lotus* field emergence; further research is necessary to develop a test which improves prediction for field emergence and to elucidate what factors influence seed vigour.

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