VARIATION IN RADICLE ELONGATION RATE IN MACROPTILIUM ATROPURPUREUM

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ABSTRACT
The northern Australian environment is characterised by high temperature and unreliable rainfall during spring and summer and seedling establishment under these conditions is frequently risky. Plants with rapid radicle elongation should be better able to establish under these conditions, as they would be able better to keep in pace with the receding front of moist soil after rainfall, enabling them to capture soil water. A controlled experiment was carried out in which differences in radicle elongation between accessions of the pasture legume *Macroptilium atropurpureum* were investigated. There were large differences between accessions in radicle elongation rate during the first four days after germination, and these were negatively related to provenance rainfall. Variation in radicle elongation may also exist in other tropical forage species and there may be benefit in examining this variation when seeking germplasm adapted to arid climates.

KEYWORDS
Macroptilium atropurpureum, radicle elongation, temperature

INTRODUCTION
The selection of genotypes for evaluation, and success in the subsequent development of new improved cultivars of forages, benefits from an understanding of the variation contained within available germplasm collections. This is especially so where a plant trait is likely to have adaptive significance. Procedures for characterisation of germplasm collections should include an attempt to quantify such variation to ensure that the plant evaluator seeking material for a specific ecological niche has the opportunity to include the most appropriate germplasm (Pengelly and Williams, 1993). Northern Australia is a tropical and sub-tropical region characterised by extremely variable rainfall and high temperature during late spring and summer. In this climatic environment, conditions at or near the soil surface may be conducive to seedling establishment for only a short time, resulting in failed or patchy establishment. Based on a survey of farmers and graziers, Clements (1995) reported that difficulty with pasture establishment was perceived as being the major constraint to the use of improved pasture species.

In legumes, rapid elongation of the radicle after germination is likely to assist seedlings to survive by improving their ability to keep up with the receeding front of moist soils front following rainfall. However there is little information on the variation in radicle elongation within collections of forage germplasm. This paper reports a study on variation in radicle elongation in the tropical forage legume *Macroptilium atropurpureum*, a legume which is widely used in south-eastern Queensland.

MATERIALS AND METHODS
Eight accessions of *M. atropurpureum* were selected from the total collection of 200 accessions held at the Australian Tropical Forages Genetic Resource Centre (ATFGRC). The accessions selected were from environments ranging from humid tropical to semi-arid subtropical (Table 1). The cultivar Aztec was included as a control. The seed lots used for the experiment were from harvests taken over the 2-9 year period preceding the experiment and all had been stored at 5˚C and 20% RH since the time of harvest. Seeds were individually scarified using a scalpel blade and placed onto germination towels; these were rolled and placed in unlit germination cabinets in a random order. There were three replicates, each including five seeds of each entry. Two temperature treatments were used, 20˚C and 25˚C. Radicle length was measured daily from the time of germination.

RESULTS AND DISCUSSION
Accessions differed in the rate of radicle elongation in both temperature treatments (Table 1, Fig 1). Radicle length continued to increase linearly for 4 days after germination, up to a range of 60-115mm and 70-170mm at 20˚C and 25˚C respectively. In both treatments, CPI 84989 had the fastest rate of elongation, 29 mm day^{-1} and 39 mm day^{-1} respectively while 87869 was the slowest in both treatments at 14 and 16 mm day^{-1} respectively. The fastest rate of elongation was of accessions originating from semi-arid and arid environments. Radicle extension rate, averaged over germination temperature, was inversely correlated with provenance rainfall (r^2 = -0.82; $p < 0.01$)(Table 1). CPI 84989 was collected from Baja California in Mexico at a site where the mean annual rainfall is 250 mm . Similarly CPI 90844, 90338 and 90748, which were consistently among the accessions with the most rapid elongation, were collected from semi-arid regions of northern Mexico. Accessions with the lowest rate of radicle emergence were collected from more humid environments such as Honduras and Vera Cruz in Mexico. The cultivar Aztec was in the middle of the range, suggesting that there could be opportunities for developing cultivars with improved ability to establish in semi-arid environments. Differences in rate of radicle extension could be due to one or more of several physical, physiological or chemical attributes. One such attribute is seed size. A comparison of seed weight of accessions (Table 1) revealed that there are, in fact, large differences between accessions in seed size and that at least some accessions originating from a semi-arid environment, e.g. 90338 and 90748, have larger seeds than accessions from more mesic environments. However, the low and statistically nonsignificant correlation coefficient (r^2 = 0.01) between seed weight and radicle elongation rate indicates that seed weight is not a causative factor. Conditions under which seed had matured or had been stored could also contribute to differences in radicle elongation rate. The seed used in this experiment was collected from plants growing in a glasshouse where they would have avoided deleterious weather conditions, and they had been stored under cool dry conditions where it is unlikely that significant deterioration would occur. In addition >95% of seed of all accessions germinated in both treatments indicating that all seed samples were of high viability and vigour. Rapid radicle elongation is likely to be an advantageous trait for legumes to be used in the northern Australian pastoral industry and the results from this experiment indicate that there is variation within *M. atropurpureum* for this trait. It is likely that comparable variation occurs within other legume genera utilised as forages by the grazing industry. With establishment being identified as a major constraint to improved pasture use in tropical and sub-tropical Australia, researchers aiming to develop forage legume cultivars for arid and semi-arid regions should consider including evaluation of this trait in the characterisation and selection process.

REFERENCES
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Table 1
Provenance data, seed weight and rate of radicle extension (averaged over temperatures) of *Macroptilium atropurpureum* accessions. Data are presented in order of radicle extension rate.

Accession*	Country (°)	Latitude (°)	Longitude (mm)	Rainfall	Seed wt g/100 seeds	Mean radicle elongation rate (mm/d)
84989	Mexico	22.48N	109.50W	230	1.44	34.3
90748	Mexico	25.25N	103.40W	250	2.40	31.0
90844	Mexico	27.55N	110.35W	250	1.85	30.0
90338	Mexico	27.50N	113.30W	150	2.20	27.9
cv. Aztec	-	-	-	-	1.24	21.7
37275	Honduras	14.09N	87.02W	-	1.43	20.5
61231	Mexico	18.30N	92.39W	1400	1.43	19.9
82306	Cuba	23.10N	82.08W	1300	1.44	19.4
87869	Mexico	19.31N	96.52W	1200	2.43	15.1

* Australian Commonwealth Plant Introduction number.

Figure 1
Elongation rates of radicles of 9 accessions of *Macroptillium atropurpureum* at 20°C and 25°C.