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Establishment of *Desmodium ovalifolium* on an Ultisol

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RINGKASAN

Kesan beberapa rawatan pelelasan terhadap percambahan biji-benih Desmodium ovalifolium *(Prain) telah dikaji. Berikutan dengan itu satu percubaan pasuan telah dilakukan untuk menilai pengaruh kapur, posforas dan suntikan* Rhizobium *terhadap hasil bahan kering, pembintilan dan kandungan nitrogen dan posforas dalam tumbuhan. Pelelasan mekanikal dengan cakaran kertas pasir meninggikan percambahan dengan kadar 30 peratus. Kapur menambahkan hasil bahan kering dan pembintilan sehingga kadar kapur 1000 kg/ha. Posforas meninggikan bilangan bintil dan kandungan posforas dalam daun dan batang. Suntikan* Rhizobium *meninggikan hasil bahan kering, pembintilan dan kandungan nitrogen dan posforas dalam daun dan batang.*

SUMMARY

The effect of various scarification treatments on the germination of seeds of Desmodium ovalifolium *(Prain) was studied. Following this a pot trial was conducted to evaluate the effects of lime, phosphorus and* Rhizobium *inoculation on the dry matter yield, nodulation and the nitrogen and phosphorus content in the plant. Mechanical scarification by abrasion with sandpaper improved germination by 30 percent. Liming up to the highest level of 1000 kg/ha significantly increased dry matter yield and nodulation. Phosphorus increased nodule number and phosphorus content in leaves and stems. Inoculation increased dry matter yield, nodulation and the levels of nitrogen and phosphorus in the leaves and stems.*

INTRODUCTION

Desmodium ovalifolium, also known as D. *heterocarpon,* is a shrubby or procumbent perennial legume which grows up to two meters. It is distributed in eastern and southeastern Asia, including Malaysia and Polynesia and also on the east coast of Africa (Bogdan, 1977). In Malaysia it has been included in cover crop mixtures for rubber estates (Edgar, 1958). It is adapted to dense shade, poor soils and drought conditions (Rijkebusch, 1967). D. *ovalifolium* has recently received attention as a pasture legume species in Malaysia. However, one of its drawbacks is its slower rate of establishment compared to other pasture legumes. This experiment is aimed at investigating some of the factors that may affect its germination, initial growth and nodulation.

MATERIALS AND METHODS

Experiment I. Seed scarification

Seven scarification treatments were imposed on four replicates of *Desmodium ovalifolium* seeds. Each replicate consisted of 100 seeds. The treatments were:–

- T_0 Control
- T_1 soaked in hot water (80° C) for 5 minutes
- T_2 soaked in hot water (80° C) for 10 minutes
- T_3 soaked in hot water (80° C) for 15 minutes
- T_4 soaked in concentrated sulphuric acid for 5 minutes
- T_5 soaked in concentrated sulphuric acid for 10 minutes
- T_6 soaked in concentrated sulphuric acid for 15 minutes
- T_7 mechanical scarification by rubbing seeds between two boards lined with sand paper for about 15 seconds.

After treatment the seeds were placed in covered petri dishes lined with moist blotting paper. They were placed in germination cabinets set at 20°C (night) for 10 hours and 25°C (day) for 14 hours. The number of germinated seeds were recorded every alternate day for 21 days.

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Experiment II. Pot trial

Seeds of *D. ovalifolium* were sown in black polythene bags of size 23 x 30 cm and 0.9 mm thick, containing 3 kg of air-dried soil. The soil was obtained from the surface layer (0-15 cm) of an Ultisol (Serdang sandy loam) which was formerly under rubber. The soil samples were analysed in the laboratory and the chemical data are shown in Table 1.

TABLE 1
Chemical properties of Serdang sandy loam *(Typic Paleudult)* used in the pot trial.

pH (1/2.5 water)	5.0	
Total nitrogen	0.12%	ppm
Available phosphorus	46.87	ppm
Available potassium	283.5	ppm
Available calcium	68.53	ppm
Available magnesium	9.05	ppm
Available sodium	268.0	ppm

ppm : parts per million

The treatments imposed consisted of factorial combinations of three levels of lime, three levels of phosphorus and either with or without *Rhizobium* inoculation. This gives a total of 18 treatment combinations. The summary of the treatments is as follows:—

1. LIME
   - L_0 control
   - L_1 500 kg/ha (0.77 g/bag) of ground magnesium limestone (GML)
   - L_2 1000 kg/ha (1.54 g/bag) of GML
2. PHOSPHORUS
   - P_0 control
   - P_1 phosphorus at 50 kg P/ha (0.73 g/bag) as Triple superphosphate
   - P_2 phosphorus at 150 kg P/ha (2.19 g/bag) as Triple superphosphate
3. INOCULATION
   - I_0 control
   - I_1 inoculated with *Rhizobium* culture for cover crops *(Centrosema pubescens, Calapogonium mucunoides, Pueraria phaseoloides)* obtained from the Rubber Research Institute of Malaysia.

Lime was mixed into the soil medium two weeks before sowing. Phosphorus and other basal fertilisers were applied a day prior to sowing. The other fertilisers applied are shown in Table 2. Thinning was carried out two weeks after germination to maintain a final stand of six plants per bag.

TABLE 2
Basal fertilisers other than phosphorus applied to all treatments

Fertilizer	kg/ha	g/bag
Potassium chloride	40 (K)	0.1237 (KCl)
Sodium molybdate	0.1 (Mo)	0.000388 (Sodium molybdate)
Copper sulphate	8	0.0123
Zinc sulphate	8	0.0123

The experiment was terminated on the 85th. day after sowing. Soil was carefully washed away from the roots and the nodules were counted. After drying for 48 hours at 60°C the nodules were weighed. The total dry weight of plants per bag was also measured.

RESULTS

Experiment 1. Scarification

Mechanical scarification by rubbing seeds between two sand papers gave the best germination of 71.5 percent. The percentage germination for the control was only 39.2 percent. All other treatments produced lower germination percentages than the control.

Experiment II. Pot trial

Lime:

Liming had a positive effect on many of the parameters measured. The total plant dry weight and the dry weight of nodules of *D. ovalifolium* increased almost linearly at both levels of lime application (Table 3). However, a significant increase in nodule number occurred only at the highest lime rate of 1000 kg/ha. There was no effect of lime on nitrogen content of the leaf but nitrogen content in the stem increased significantly at the highest level of application (Table 4). Phosphorus levels in both the leaf and stem components responded positively to lime application.

Phosphorus:

Although phosphorus applied at the rate of 50 kg/ha increased nodule number, it had no effect on nodule dry weight. Total dry weight of

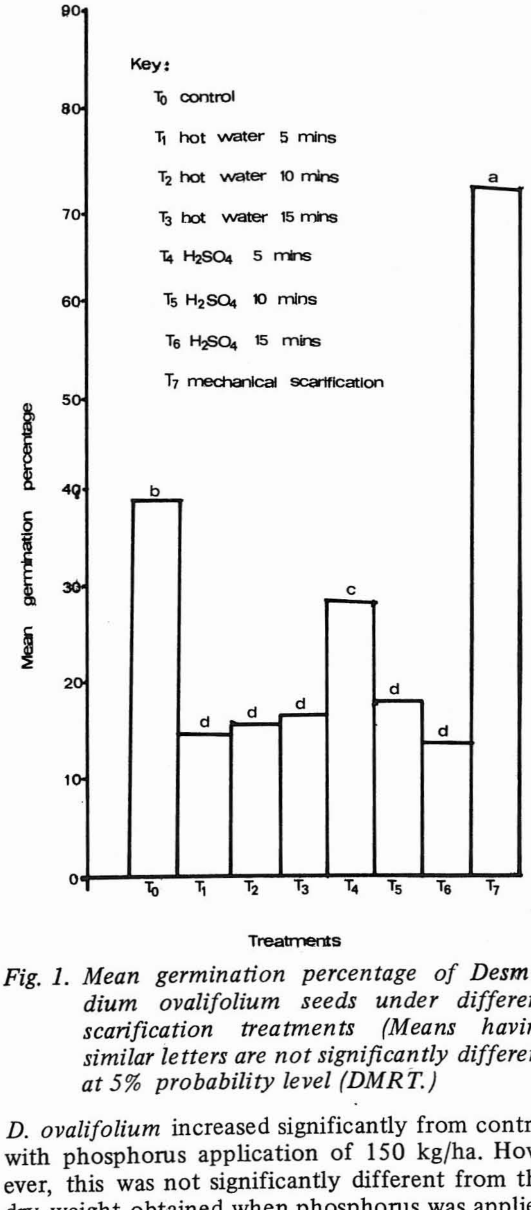

Fig. 1. Mean germination percentage of Desmodium ovalifolium seeds under different scarification treatments (Means having similar letters are not significantly different at 5% probability level (DMRT.)

D. ovalifolium increased significantly from control with phosphorus application of 150 kg/ha. However, this was not significantly different from the dry weight obtained when phosphorus was applied at 50 kg/ha (Table 3). Phosphorus content in both leaf and stem increased significantly at both levels of phosphorus application. There was no significant effect of phosphorus on nitrogen content in the leaf although stem nitrogen content responded positively (Table 4).

Inoculation:

Nodule number and dry weight, total dry weight of plants and the content of nitrogen and phosphorus in leaf and stem were all significantly higher in inoculated treatments than in uninoculated treatments (Table 3 and 4).

Interactions:

There was a significant positive teraction between lime and inoculation on the number of nodules per bag. Nodule number increased with inoculation only in those treatments which received lime. There was no effect of inoculation on nodule number in unlimed treatments (Fig. 2)

DISCUSSION AND CONCLUSION

The 30 percent increase in germination of seeds that were mechanically scarified suggests the occurrence of hardseededness in *D. ovalifolium*. It is therefore desirable to practise scarification before planting out under optimum conditions. The choice of the scarification method is important since a large percentage of seeds was damaged by the acid and hot water treatments. The small sized nature of the seeds may have rendered them susceptible to damage by acid and hot water. Mechanical scarification should thus be advocated.

Lime and inoculation appear to be equally important in promoting the nodulation and initial growth of *D. ovalifolium* on Serdang series soil. The beneficial effects of lime in providing a suitable environment for the survival of indigenous as well as introduced rhizobia especially during the early stages of infection have been shown by Munns (1970). Apart from its neutralizing effect on soil pH, lime has been shown to encourage *Rhizobium* multiplication (Anderson and Moye, 1952). The availability of calcium and molybdenum, both essential for *Rhizobium*-legume symbiosis in acid soils, is also improved by liming (Bould and Hewitt, 1963). Liming has also been shown to reduce the concentration of some metallic ions, chiefly manganese and aluminium, which are toxic to most legumes and rhizobial strains (Dobereiner, 1966). The significant interaction between lime and inoculation as shown in this experiment clearly demonstrates the positive effect of lime on *Rhizobium* survival and vigour. From the linear response of plant dry matter yield to liming it is likely that liming rates above 1000 kg/ha would produce even higher yields.

The presence of nodules in uninoculated treatments indicates that native rhizobia which are compatible with *D. ovalifolium* are present in the soil. However, inoculation is strongly recommended based on the positive responses obtained in all the parameters measured. The results also show that *D. ovalifolium* is not highly specific in its *Rhizobium* requirement since the *Rhizobium* culture used was not specific for this species.

TABLE 3
Main effects of lime, phosphorus and inoculation on nodulation and total dry weight of *Desmodium ovalifolium*

Treatments	Nodule number	Nodule dry weight (g)	Total dry weight (g)
No lime	255 a	0.2943 a	9.4434 a
Lime 500 kg/ha	298 a	0.3673 b	11.1047 b
Lime 1000 kg/ha	433 b	0.5039 c	13.5285 c
No Phosphorus	288 a	0.3463 a	9.9285 a
Phosphorus 50 kg/ha	357 b	0.4006 a	11.7475 ab
Phosphorus 150 kg/ha	352 b	0.4000 a	12.3978 b
Not Inoculated	296 a	0.3403 a	9.0560 a
Inoculated	369 b	0.4323 b	13.6599 b

All values are on a per bag basis.
Means followed by the same letter for each factor are not significantly different at 5% level of probability (Duncan's Multiple Range Test)

TABLE 4
Main effects of lime, phosphorus and inoculation on nitrogen and phosphorus content in *Desmodium ovalifolium*

Treatments	Leaf Nitrogen %	Stem Nitrogen %	Leaf Phosphorus %	Stem Phosphorus %
No lime	2.27 a	1.01 a	0.31 a	0.61 a
Lime 500 kg/ha	2.18 a	1.01 a	0.53 b	0.78 b
Lime 1000 kg/ha	2.33 a	1.07 b	0.70 c	0.80 b
No phosphorus	2.32 a	1.00 a	0.47 a	0.69 a
Phosphorus 50 kg/ha	2.20 a	1.04 ab	0.52 b	0.73 b
Phosphorus 150 kg/ha	2.20 a	1.05 b	0.61 c	0.76 c
Not inoculated	2.17 a	0.99 a	0.52 a	0.71 a
Inoculated	2.35 b	1.07 b	0.55 b	0.75 b

Means followed by the same letter for each factor are not significantly different at 5% level of probability (Duncan's Multiple Range Test)

Responses of some pasture legumes to phosphorus application have been shown on the inland soils of Peninsular Malaysia (Kerridge and Tham, 1977). Phosphorus is one of the primary limiting nutrients in the establishment of tropical pasture legumes (Norris, 1972). It has been shown to stimulate nodulation in many tropical pasture legumes (Gates, 1974). In this experiment the beneficial effect of phosphorus on nodulation and initial growth is not as obvious as that of lime and

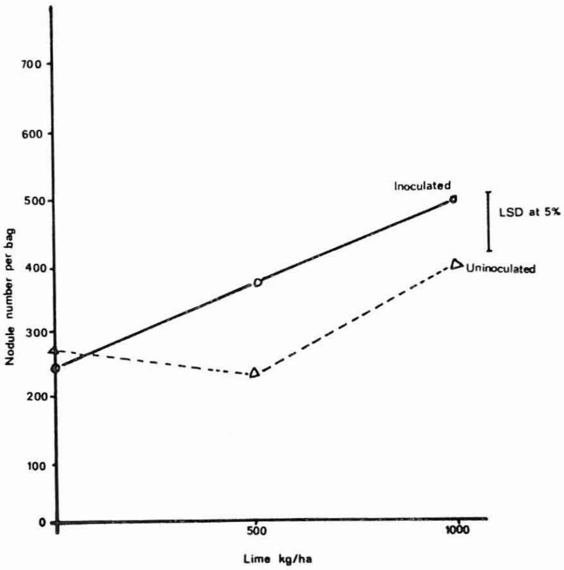

Fig. 2. Effect of lime × inoculation on nodule number.

inoculation. Nodule number but not the nodule dry weight increased with phosphorus application. This suggests that there is a greater number of smaller nodules when application of phosphorus increased. The effect on dry weight of plants became significant only at phosphorus application of 150 kg/ha. Phosphorus rate of between 50 and 150 kg/ha would be suitable as a basal application for establishing *D. ovalifolium* under the Serdang series soil.

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