韓國作物學會誌 第10號(1971. 12)
J. Korean Soc. Crop Sci. Vol. 10

The Effects of the Seed Inoculation, Pelleting, and Liming on the Nodulation and Growth of Lucerne(*Medicago sativa L.*)

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황갈색 고원 토양에 있어 근류균 접종, pelleting 및 석회시용이 Lucerne(*Medicago sativa L.*)의 근류형성 및 생육에 미치는 영향

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적 요

뉴지랜드의 황갈색 고원 토양에 있어 Lucerne의 근류형성 및 생육에 미치는 근류접종, pelleting 및 석회시용의 효과를 시험코저 5개 수준의 종자 처리(불접종, 접종, 접종 석회 pelleting, 접종인산 백운석 50/50 pelleting, 접종활석 pelleting과 석회시용(25kg/10are)을 비교하고 그들의 상호작용을 관찰하였던바 다음과 같은 결과를 얻었다.

1. 산성토양에서 Lucerne의 효과적 근류 형성에는 석회시용과 종자의 근류균 접종 및 pelleting이 필요하다.
2. 접종 종자를 적당한 재료로 싸면 근류형성을 좋게한다.
3. Lucerne의 종자 pelleting은 석회시용 요구량을 감소시키는 수단이 될 수 있다.
4. 황갈색 고원 토양에서는 석회분말이 좋은 pelleting재료가 된다.
5. 종자에 접종하지 않거나 pelleting을 하지 않은 종자의 파종시는 석회시용이 효과적이다.
6. pelleting종자 사용은 석회시용에 소요되는 품과 경비를 절감시킬 것이다.

Introduction

Common lucerne or *Medicago sativa* is a best forage crop and it has wide range of uses such as pasture, hay and silage, alfalfa meal. It is considered to be native to the low lands of Asia minor[10,11] where its natural habit is neutral to slightly alkaline soils, rich in bases, in a semi-arid climate.

Upon introduction to many other countries, it thrived on soil of simmilar pH and bases status. Lucerne was difficult to establish on acid soils and it was not until management practices such as inoculation and liming were developed that early lucerne growers successful on these soils, Today lucerne is grown widely on soils in humid climate in many parts of the world.

Many reseach have been studied on the improved method that could be adaptable in unfavourable soils for growing the legumes. In certain problem soils, however, there may be improved nodulation if very high levels of inoculum are used. Field trials white clover on pumice soils in the North Island[16] and with subterranean clover on problem hill country in southern New South Wales[7] have shown that increasing the level of inoculum on the seed increased the proportion of plants which became nodulated, and the mean weight of these plants. Hely[7,8] has developed a "three-step" method of inoculation and pelleting subterranean clover seed to achieve good nodulation and growth

on elevated problem country of New South Wales in Australia.

It is now well known that coating of inoculated legume seed with certain materials may assist in nodulation particularly on acid soils, and pelleting of lucerne seed may be a means of reducing the need for heavy liming. Improved nodulation and establishment of lucerne has been obtained from the use of lime and certain other pellets [2,6,12] and in South Australia White[19] found that on an acid sand normally inoculated lime pelleted seed gave nodulation equal to that obtained where ten times normal inoculation was used without pelleting. White[21] compared several types of pellets sown on an upland yellowbrown earth(pH5.5) in the South Island tussock country and concluded that finely divided lime was the best material to use. In a pot trial with this soil lime pelleting of lucerne resulted in nodulation equal to that obtained from heavy liming. Similar results were obtained in pot trial reported by Hayman[6].

In this small scale pot trial, the author intended to find out the best pelleting material and compared several types of pellets, including the pellets which were not tested by others, sown on upland yellow brown earth in pot under the supervision of Dr. White, senior lecturer, at the Lincoln college, Canterbury University in N.Z. during the period of March to July 1968.

1. Materials and Methods

The soil used was from Mesopotamia, Ragitata Valley, N.Z. It was an upland yellow-brown earth, Mesopotamia series and was deficient in both P and S and probably also in Mo. Soil pH was 5.5 and undisturbed cores was obtained on March 13 '68.

The pot used held approximately 1000gr of soil(dry) and surface area of cores was 129 sq. cm.

The trial was a multiple factor design where five seed treatments were combined with two soil treatments. i.e. 5×2 treatments. Each treatments were replicated 5 times.(Table 1).

Superphosphate and Molybdenum were applied for the basal dressing. Superphosphate was sieved through a fine sieve and added 0.64gr/pot broadcast. It equals

Table 1. Treatments

Fector	Treatments
Seed	Uninoculated
	Inoculated
	Inoculated plus lime pelleted
	Inoculated plus 50/50 Phosphate/dolite pelleted
	Inoculated plus talc pelleted
Soil	No lime
	25kg/10a

25kg per 10a on a pot area basis. Molybdenum was applied with 0.031gr ammonium molybdate dissolved in 500ml H_2O. It was pipetted 5 ml/pot and it equals 14.01gr per 10a. 3.2gr of fine $CaCO_3$ per pot was broadcasted for the addition of lime. It equals 25kg per 10a on a pot area basis. Pots were normally watered individually to constant weight every second day.

For the inoculation 5.0ml of Adlife suspension(100 ml of H_2O was added to the 7.5gr Adlife inoculant) which provides approximately 2000 rhizobia per seed, was added to the 114 gr of Wairau lucerne seed, 75% germination prooved, and mixed thoroughly. After that the seeds were spread on newspaper out of sun light and allowed to dry. For the pelleting of inoculated seed, three lots of seed were weighed out and placed 400 ml beakers. To each lot of seed 2.0 ml of mthyl cellulose sticker was added and mixed until seed was covered thoroughly.

Immediately each lots of seed and sticker was mixed, added 20 gr of coating material and rotated rapidly in beaker until a firm pellet was formed. Pelleted seed were allowed to dried for 30 minutes on newspaper before sowing. 17 seeds per plot were sowed at 0.64 cm below the surface. The plants were thined at the cotyledone stage, before the unifoliate leaf had appeared, to 10 seedlings per plot.

The plots were soaked in tube,soil core was tipped out from pot, and each lucerne plant, both the roots and tops, were removed by washing carefully in order not to knock off the nodules from roots. For the dry matter analysis the plants were severed just below cotyledones and returned roots with nodules to plastic bag. Tops were kept from nodulated plants and unnodulated plants separately, placed in envelopes, laveled,

dried in oven at 70°C and weighed.

2. Experimental results and Discussion

There are high significant differences in percetages nodulation among the seed treatments and also lime treaments(Table 3). There was also high interaction between seed treatment and liming in percentage nodulation. The high significant differences in No. of crown nodule and dryweight per plant of nodulated were found in seed treatments, and the differences were recognized also in other single effect and interaction except the effect of liming and interaction between every seed tretment and lime treatment for the No. of lateral nodule(Table 2, 3).

The reason that statistical significant difference among the treatments in No. of lateral nodule was found, seems to be the large error existed in replication, and too young plant to find out the statistical significant differences.

There were highly significant differences between the

Table 2. The relation between seed treatments and liming on nodulation and growth

Seed treatments	Item / Liming	Percentage of nodulation	No. of crown nodule	No. of lateral nodule	Dry weight per plant nodulated mg/plant
Uninoculated	No lime	0	0	0	0
	25 kg lime per 10 a	7.38	0.20	0.14	2.80
Inoculated: Non pelleting	No lime	17.74	0.40	0	3.12
	25kg lime per 10 a	100.00	2.08	0.26	33.16
Inoculated: Lime pelleted	No lime	98.08	2.42	0	37.50
	25 kg lime per 10 a	96.78	2.56	0.72	25.64
Inoculated: 50/50 phosphate dolmite/ pelleted	No lime	94.00	2.22	0.32	30.22
	25kg lime per 10 a	83.14	2.40	0.38	28.52
Inoculated: talc pelleted	No lime	47.92	2.38	1.02	30.20
	25 kg lime per 10 a	87.98	2.08	0.46	27.58

Table 3. The single effect of treatments on nodulation and growth

	Treatments / Item	Percentage of nodulation	No. of crown nodule	No. of lateral nodule	Dry weight per plant nodulated mg/plant
Seed treatments	Uninoculated	3.69%	0.10	0.07	1.40
	Inoculated	58.67	1.24	0.13	18.14
	Inoculated, lime pelleted	96.43	2.49	0.36	31.57
	Inoculated, 50/50 phosphate/dolmite pelleted	88.67	2.31	0.19	29.37
	Inoculated, talc pelleted	67.97	2.23	0.23	28.89
Lime	No lime	51.07	1.48	0.33	20.21
	25 kg lime/10 a	75.08	1.86	0.39	23.52
L.S.D.	.01	3.90	0.22	0.20	13.88
	.05	3.48	0.20	0.18	12.40

note; crown nodule: with 2.54cm of the soil surface.
Lateral nodule: on taproot and lateral roots further than 2.54 cmof soil surface.

every pelleting material in the percentage of nodulation (Table 3). The highest percentage nodulation was obtained with the inoculated and lime pelleted seed treatment(Table 3) and it would be concluded that finely divided lime was the best material to use.

Liming also affected the percentage of nodulation (Table 3) and there were especially remarkable effect in case of the seed was not inoculated or not pelleted with proper materials. It was also found that liming was also effective when the seed was inoculated and pelleted with inferior materials and the liming was not effective in case of the excellent pelleting materials were used(Table 2).

There were also same tendency in number of crown nodule, number of lateral nodule and dry weight per plant of nodulated as in percentage of nodulation except lime effect on number of lateral nodule(Table 2, 3).

These results suggest that in some moderately acid soils effective nodulation of lucerne can be obtained by lime pelleting of inoculated seed. Acid soils are identified in practice by their low pH. However, the effects of soil acidity on plants are diverse and many factors contribute towards this "soil acidity complex"[6] Application of lime is commonly used to overcome these problems, and lucerne shows a greater response to lime than almost any other crops. Lime may affect nodulation and establishment of lucerne in several ways, and not all of these effects are completely understood. Lime is know to increase the survival and mulitplication of rhizobia in the soils through raising pH; raising pH may also allow better root development and growth of the host plant, possibly by reducing toxic levels of management and aluminium in the soil and plant. The calcium ion is required by legumes for growth and is essential for the nodulation, even greater amounts are required for nitrogen fixation.

One of the main functions of lime in lucerne nodulation is raising soil Ph, thus allowing the rhizobia on the seed to survive and multiply in the soil. Although heavy rates of lime are commonly used for this purpose, recent work has shown that much smaller ammounts either drilled with the seed or coated around the individual seeds may be at least as effective and much cheaper On slight to moderately acid sands in South Australia lucerne is commonly established by drilling with 37.5kg to 25kg of 25kg calcium carbonate per 10 are.[17] On strongly acid sands in the same area White[19] found that nodulation of lucerne was significantly better where 200 kg of lime was drilled with the seed than where 1 ton was broadcast and cultivated into the sand(Table 2).

Pellets perform several functions[5] but in lucerne the main effect of the lime pellet or other alkaline seed coating is probably the raising of soil Ph immediately adjacent to the seed, thus permitting better survival and or multiplication of the rhizobia. Lime also supples calcium which is reqired for nodulation and which may be absent or reduced in availability in acid soils. The significant improvement in nodulation of lucerne in acid soils where lime pelleted seed is used is in marked constant to the results obtained in South Island tussock country in N.Z. by Adams[1] and Cullen and Ludecke[3] with lime pelleted clover seedwhere depressions in nodulation and or plant growth were obtained. It is obvious that the effects of seed pelleting on nodulation are complex and that *Rh. meliloti* is affected quite differently from *Rh. trifolii*.

3. Summary

To investigate the effects of seed treatments and liming on nodulation and growth of lucerne(*Medicago sativa L.*) in an upland yellow-brown earth in N. Z. the five levels of seed treatments(Uninoculated, Inoculated, Inoculated plus lime pelleted, Inoculated plus 50 /50 phosphate/dolmite pelleted, Inoculated plus talc pelleted), and 2 levels of lime applications (0, 25kg/10a) were compared and their interactions were observed, and then the following results were obtained.

1. In oder to obtain the effective nodulation of lucerne on acid soil it is usually necessary to apply lime and inoculate the seed.

2. The coating of inoculated lucerne seed with adequate materials will promote the nodulation.

3. The pelleting of lucerne seed may be a means of reducing the need for the heavy liming.

4. The finely grounded lime was the best material to use on an upland yellow-brown earth.

5. When the seed were not inoculated or pelleted with inferior material, liming is very effective for the nodulation and growth of lucerne.

6. The pelleting seed will reduce the laborious work and expenditure.

4. Acknowledgments

I am indebted very much to Dr. White for his supervisi on and providing the materials and facilities.

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