韓草誌(J. Korean Grassl. Sci.) 13(4) : 274~277, 1993

Effects of Lime and Phosphate Applications on Growth and Nitrogen Fixation of Alfalfa in Acid Soil

Woo Bock Chun, Ki Chun Choi, Jung Chul Kim, Dong Hoo Kim and Kwang Hyun Kim

酸性土壤에서 石灰와 燐酸施用이 Alfalfa의 生長 및 窒素固定에 미치는 影響

全宇福 · 崔基春 · 金正喆 · 金東厚 · 金光鉉

摘 要

本 試驗은 石灰(0, 250, 500, 1,000kg/10a)와 燐酸(0, 17, 34kg/10a) 施用이 alfalfa(*Medicago sativa* L.)의 生長 및 窒素固定에 미치는 影響을 究明하기 위해 全南大學校 農科大學內 温室에서 pot로 수행되었다.

播種後 9週에 alfalfa의 地上部와 地下部의 乾物重 및 아세틸렌 還元力에 있어서 石灰 및 燐酸施用 效果가 나타났으며($p<0.05$), 播種後 14週(開花初期)에는 alfalfa의 地上部와 地下部의 乾物重에 있어서 石灰施用 效果는 認定되지 않았으나 燐酸施用이 증가함에 따라서 乾物重은 증가하였다($p<0.01$). 또한 石灰 및 燐酸 施用이 증가함에 따라서 아세틸렌 還元力은 有意的으로 증가하였다($p<0.05$).

播種後 9週에서 全 窒素含量은 石灰 및 燐酸 施用區에서 無施用區보다 감소되었으며($p<0.05$), 播種後 14週에서는 石灰 施用區는 無施用區보다 全 窒素含量이 증가되었으나 燐酸 施用區는 無施用區보다 낮아지는 傾向을 보였다($p<0.05$).

(Key Words: Alfalfa, Nitrogen fixation, Growth, Lime, Phosphate)

Ⅰ. INTRODUCTION

Alfalfa in leguminous plants was used cutting and grazing as a perennial legume but not cultivated widely in Korea. Most of field soil in Korea is highly acid soils and this soil conduction had bad influence on growth and nitrogen fixation of alfalfa. A soil pH range of 6.8 to 7.5 was generally recommended for alfalfa production.

Alfalfa fixes greater amounts of atmospheric nitrogen by symbiotic N_2 fixation than most other species. Alfalfa needs small amount of chemical fertilizer. Because large amount of chemical fertilizer application raises environmental pollution, biological nitrogen fixation became the most important concern at the present time.

Since alfalfa in leguminous plants is not adapted to highly aicd soils of Korea generally, we tried to investigate the effect of lime and phosphate applications on growth and nitrogen fixation of alfalfa under acid soil and Korean climate conditions.

Ⅱ. MATERIALS AND METHODS

The experiment was carried out at Animal Research Station, College of Agriculture, Chonnam National University. Alfalfa was established in a greenhouse by seeding into pots 20 cm in diameter and 18 cm in depth containing 1:1 mixture of soil and vermiculite with four different levels of lime (0, 250, 500 and 1,000 kg/10a), three different levels of phosphate (0, 17 and 34 kg/10a), one levels of nitrogen (5 kg/10a), potassium (20 kg/10a), and boron (3 kg/10a). Alfalfa seeds were inoculated with *Rhizobium meliloti*. Alfalfa of 10 plants were planted in the pot (soil pH 5.21).

全南大學校 農科大學(College of Agriculture, Chonnam National University, Kwangju 500-757, Korea)

The samples of shoot and root were taken from each pot at 9 (vegetative stage) and 14 weeks (eárly bloom stage) after sowing. Roots of alfalfa were seperated from the shoots. After the roots were washed with running water until free of soil, nitrogen fixation activity of nodule was measured by using acetylene reduction activity. Specific activity was defined as nano (n) moles of etylene produced per hour, per grames of nodule. Data were presented as the mean of four replications.

Shoots and roots of alfalfa were dried at 75℃ for 48 hours and the weight of the dry matter of those was measured. These samples were analyzed total nitrogen contents.

Ⅲ. RESULTS AND DISCUSSION

1. Dry matter weight

Dry weight (DM) of each part in alfalfa was measured at 9 and 14 weeks after sowing. The results were shown in Table 1.

The effect of lime was not significantly different between levels on shoot weight of alfalfa at 9 and 14 weeks after sowing. The effect of lime application on root weight was significantly different at 9 weeks after sowing ($p<.01$) as reported by Lee and Lee (1981), but not significantly different at 14 weeks after sowing.

Phosphate application significantly increased both weights of shoot and root of alfalfa at 9 and 14 weeks after sowing ($p<.01$). Yun (1971) reported that lime application increased the absorption of phosphate by ladino clover in highly acid and phosphate deficient soil. The interaction of lime and phosphate was effective on the weights of shoot and root of alfalfa at 9 weeks after sowing ($p<.05$), but was ineffective at 14 weeks after sowing.

Table 1. Dry matter weight and acetylene reduction activity of each part of alfalfa at 9 and 14 weeks after sowing.

Treatment (kg/10a)		9 Weeks			14 Weeks				
		Dry weight (g/10 plants)		C_2H_4 nM/ 10 plants/ hr.	Dry weight (g/10 plants)			C_2H_4 nM/ 10 plants/ hr.	C_2H_4 nM/ Nodule DMg/hr.
		Shoot	Root		Shoot	Root	Nodule		
Lime	0	1.24^a	0.51^b	4.85^b	6.78^a	5.07^a	0.034^a	16.14^c	686.15^c
	250	1.22^a	0.61^b	46.15^{ab}	6.51^a	6.78^a	0.040^a	770.50^b	7564.54^b
	500	1.53^a	0.80^{ab}	58.30^{ab}	6.75^a	5.85^a	0.053^a	5131.75^a	112853.58^a
	1000	1.73^a	1.20^a	120.95^a	6.37^a	5.37^a	0.049^a	6755.00^a	127439.54^a
F-Value		0.89	4.34**	2.74*	0.15	0.96	0.54	3.77*	8.46**
P_2O_5	0	0.42^c	0.26^c	7.65^b	4.46^c	3.06^c	0.010^c	315.44^b	23939.64^a
	17	1.58^b	0.82^b	20.83^b	7.19^b	6.21^b	0.035^b	2734.26^{ab}	74626.66^a
	34	2.35^a	1.28^a	143.95^a	8.17^a	8.03^a	0.080^a	6188.05^a	83402.74^a
F-Value		91.34**	27.35**	12.69**	60.16**	36.59**	46.09**	3.81*	1.64
Lime × P_2O_5 F-Value		10.81**	2.70*	3.45**	0.50	0.60	3.19*	1.56	0.86

^{a,b,c} Means in the same column are different($p<.05$).

*: Significant($p<.05$). **: Significant($p<.01$).

2. Nodule weight

Inoculated seeds of alfalfa produced many effective and ineffective nodules in early stage of nodule development, and nodule collection was very difficult at 9 weeks after sowing. Nodule weight of alfalfa at 14 weeks after sowing was shown in Table 1.

Nodules of pink color were associated with active nitrogen fixation. Nodule weight was not significantly different among various levels of lime application, but nodule weight was increased as phosphate levels were increased. When nodule weight was compared with acetylene reduction activity (ARA), production of effective nodule was increased as lime was applied in acid soil. As Seetin and Barnes (1977) suggested that the number of nodules were associated with ARA, result of this experiment showed a similar trend.

Pohlman (1946) and Lee and Lee (1981) reported that formation of effective nodule was increased as lime was applied.

3. Acetylene reduction activity

Results of acetylene reduction activity (ARA) were shown in Table 1. ARA per pot was increased as lime levels were increased at 9 weeks after sowing ($p<.05$). The effect of phosphate application was significantly improved as the phosphate levels were increased ($p<.01$). ARA was increased as increasing of lime and phosphate levels at 14 weeks after sowing ($p<.05$). As shown from the results of ARA per nodule weight, effective nodule was increased as lime levels were increased ($p<.01$).

The effect of lime and phosphate on ARA was significantly different at 9 and 14 weeks after sowing ($p<.05$). Results of this experiment indicated that lime and phosphate applications could be increased to nodule formation in highly acid soil.

4. Total nitrogen content

Total nitorgen (TN) contents of each part of alfalfa by various levels of lime and phosphate application was shown in Table 2. TN contents of

Table 2. Total nitrogen content of alfalfa by various levels of lime and phosphate application at 9 and 14 weeks after sowing.

Treatment (kg/10a)		Total nitrogen content (%/DM)			
		9 Weeks		14 Weeks	
		Shoot	Root	Shoot	Root
Lime	0	4.94^{a}	3.18^{a}	2.27^{b}	1.42^{bc}
	250	4.49^{b}	2.64^{b}	2.40^{b}	1.32^{c}
	500	4.58^{ab}	2.77^{b}	3.17^{b}	1.76^{a}
	1000	4.25^{b}	2.36^{c}	3.09^{a}	1.67^{ab}
F-value		5.02**	30.30**	9.25**	3.36*
P_2O_5	0	4.95^{a}	2.93^{a}	3.21^{a}	1.89^{a}
	17	4.42^{a}	2.72^{ab}	2.66^{b}	1.43^{b}
	34	4.32^{b}	2.57^{b}	2.33^{b}	1.30^{b}
F-Value		10.72**	3.83*	10.23**	14.78*
Lime × P_2O_5, F-value		9.52**	6.05**	1.73	4.20**

^{a,b,c} Means in the same column are different($p<.05$).

*: Significant($p<.05$). **: Significant($p<.01$).

shoot and root of alfalfa was significantly decreased as increasing of lime and phosphate application at 9 weeks after sowing($p<.01$). TN contents of shoot and root was decreased as phosphate levels were increased at 14 weeks after sowing($p<.05$), but TN contents of shoot and root of alfalfa was significantly increased as lime levels were increased at 14 weeks after sowing($p<.05$).

Ⅳ. SUMMARY

We investigated the effects of applications of various levels of lime(0, 250, 500 and 1,000 kg/10a) and phosphate (0, 17 and 34 kg/10a) on growth and nitrogen fixation of alfalfa (*Medicago sativa* L.).

Effects of lime and phosphate applications were significantly different on dry matter (DM) weight of each part and on acetylene reduction activity (ARA) of alfalfa at 9 weeks after sowing ($p<.05$). The effect of lime on DM of shoot and root was not significantly different at 14 weeks after sowing (early bloom stage), but that of phosphate on DM was significantly improved as increasing of phosphate levels ($p<.01$). The effects of lime and phosphate on ARA were significantly increased ($p<.05$).

Application of lime and phosphate decreased total nitrogen (TN) content of each part of alfalfa at 9 weeks after sowing ($p<.05$). The effects of lime application on TN was higher but that of phosphate application on TN was lower than no application of lime or phosphate at 14 weeks after sowing ($p<.05$).

Ⅴ. REFERENCES

1. Lee, K.H. and H.J. Lee. 1981. Effects of seed inoculation of *Rhizobium meliloti* and lime application on the early growth of alfalfa in an acid soil. Korean J. Crop Sci. 26(2):198-206.
2. Pohlman, G.G. 1946. Effect of liming different soil layers on yield of alfalfa and root development and nodulation. Soil Sci. 62:255-266.
3. Seetin, N.W. and D.K. Barnes. 1977. Variation among alfalfa genotype for rates of acetylene reduction. Crop Sci. 17:783-787.
4. Yun, I.S. 1971. Studies on the fertilizer application to ladino clover growth on Korean soil. Korean Grassl. Research Institute, Kon-Kuk Univ., 87-120.