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Effect of Growth Environment on the Root Development of Pasture Species

Ⅱ. Root distribution under contrasting field situations

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생육환경이 주요 목초의 뿌리발육에 미치는 영향

Ⅱ. 생육환경에 따른 뿌리 분포

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요 약

비교되는 포장조건에 따라 뿌리 분포 양상을 조사하기 위하여 Rhizotron법을 사용하였다. Lincoln 지역에서 토양 깊이에 따른 뿌리의 분포는 15~30 cm 깊이에 대부분의 뿌리가 분포되어 있고, 0~15 cm와 30 cm 이하에서는 분포가 적었다. 반면 Winchmore에서는 토양 깊이가 깊어질 수록 뿌리 數가 많아졌다. Mt John에서는 표토에 가까울 수록 뿌리 분포도가 더 높았으며, 시비량이 높고 灌漑를 한 곳이 뿌리 분포가 더 높았다. 모든 지역에서 토양 깊이에 따른 뿌리 數의 분포는 뿌리 길이와 같은 경향을 보여주었다. Tube법이 같은 장소에서 뿌리의 비교 연구와 장기간 뿌리 생장 연구를 하는데 좋은 방법임이 입증되었다.

(Key words : Root distribution, Root growth, Root density, Root numbers, Rhizotron technique)

Ⅰ. INTRODUCTION

Being the principal water and mineral nutrient absorbing organ, the root system plays a crucial role in the development of a plant. Therefore, an understanding of root distribution within the soil profile is important. But roots are normally inaccessible for observation, and most measurements of rooting behavior have been obtained from root systems dug out of the soil (Weaver, 1926: Dittmer, 1937; Foth, 1962; Melhuish, 1967: Melhuish and Lang, 1968).

Bohm et al. (1977) described and compared five methods of root observation. They suggested one method, using of clear tubes buried in the soil (mini-rhizotrons) which provides a technique for root observation in a natural environment which can be used repeatedly at a particular point through time.

This experiment used the rhizotron technique to determine the zone of active spring root growth under contrasting field situations, pasture type, fertility, and water status.

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Ⅱ. MATERIALS AND METHODS

Six locations in three regions, Canterbury, New Zealand, were chosen, and four tubes were established in each location.

Lincoln

High fertility, occasionlly irrigated, and grass dominant pasture

Winchmore

Mixed species pasture under high fertility (180kg superphosphate/ha/year)

1) Irrigated

2) Dryland

Mt John.(Lake Tekapo)

Relatively compact soil with pebbles, and mixed species pastures

1) Zero fertilizer-dryland, very low fertilit, and dominated with *Hieracium pilosella*

2) Low fertility dryland (100kg superphosphate/ha/year) dominated with *Lupinus polyphyllus,*

3) High fertility irrigated pasture (500kg superphosphate/ha/year) dominated with grass and *Trifolium ambiguum.*

Transparent acrylic plastic tubes (7.5 cm O.D. × 50 cm) were scribed with circumferential lines at 5 cm intervals. Soil was augered to a depth of 45 cm, and tubes were inserted. The tubes were in contact with soil. Plastic covers were placed over the portion of the tubes which extended 5 cm above the soil surface to exclude light, precipitation, dust, and animals.

Root distribution was measured photographical using two 45° inclined mirrors held at a fixed distance from camera with flash. Photographs were taken at 5 cm intervals to 45 cm. The root images made by slide projector were traced on papers. Roots seen in each segments were counted and measured length in two categories, large and small, observable. The method was not capable of discriminating root hairs. Root length density was expressed as length per unit area.

Ⅲ. RESULTS AND DISCUSSION

As shown in table 1, at Lincoln roots were most highly distributed at 25～30cm layer of soil, and rooted to 40cm deep. At Winchmore roots were more distributed at 30～35cm layer under irrigation and rooted to 45cm, while the root under unirrigation condition were distributed more at 20～25 layer than other layers, and reached to 40cm soil depth. Under dry, infertile condition with no fertilization at Mt. John most roots were distributed around top soil and showed poor rooting system. Under dry and low fertility condition at Mt. John with 100kg superphosphate/ha/year fertilization, roots were also shallowly distributed at 5～10cm layer and rooted to 25cm deep, while under irrigated fertile environment with 500kg superphosphate/ha/year fertilization roots were more deeply distributed, and roots were reached to 40cm deep.

The root distribution types were different according to the regions. The distribution of roots with depth showed most root in the 15~30 cm layer with fewer in the 0~15 cm and below 30 cm layer at Lincoln Farm. While root density increased with depth at Winchmore. At Mt. John (Lake Tekapo) roots were more distributed near soil surface. There were many roots in the upper profile than in the lower

Table 1. Root length density (mm/dm^2) of pasture plants measured by tube method at different regions and various growing conditions

Root depth (cm)	Lincoln (irrigated)		Winchmore (irrigated)		Winchmore (unirrigated)		Mt. John (p zero)		Mt. John (P 100)		Mt. John (P* 500+irrigated)	
	Lar.	Sma.	Lar.	Sma.	Lar.	Sma.	Lar.	Sma.	Lar.	Sma.	Lar.	Sma.**
0~ 5	20	241	159	309	49	125	287	524	330	758	343	708
5~10	148	366	161	611	213	302	391	507	565	623	375	810
10~15	250	367	226	460	200	533	285	352	453	458	453	923
15~20	225	762	237	424	312	770	130	180	340	326	402	638
20~25	321	637	315	458	317	894	68	117	245	185	406	640
25~30	350	729	273	798	224	546					223	547
30~35	222	255	569	702	341	546					257	390
35~40	112	229	603	616	104	356					193	297
40~45			138	120								

* P ; superphosphate.
** Lar ; large roots.
Sma ; small roots.

profile. Root density was increased with fertilizer and irrigation at Mt. John. Root number (Table 2) showed the same trends as root length(Table 1) at all regions.

In terms of technique colour film was preferable to black and white film, and more sensitive film was recommended. Though there was an advantage of use of flash, it was difficult to get sufficient light to to bottom of access hole. Using projected slides can be assessed in relative comfort of office. Tube method is good for comparative purposes, and

Table 2. Root numbers per unit area (No./dm^2) of pasture plants measured by tube method at different regions and various growing conditions

Root depth(cm)	Lincoln (irrigated)		Winchmore (irrigated)		Winchmore (unirrigated)		Mt. John (P zero)		Mt. John (P 100)		Mt. John (P* 500+irrigated)	
	Lar	Sma	Lar	Sma	Lar	Sma	Lar	Sma	Lar	Sma	Lar	Sma**
0~ 5	1	31	8	46	3	12	16	69	21	114	23	84
5~10	9	47	10	81	9	29	18	55	27	81	20	87
10~15	16	42	11	62	10	49	14	38	24	57	20	91
15~20	9	74	13	48	16	68	5	20	18	24	17	55
20~25	16	72	16	60	14	68	3	18	13	26	18	52
25~30	13	91	14	79	11	41					11	56
30~35	10	29	23	81	14	42					14	48
35~40	8	22	27	50	5	24					10	30
40~45			7	10								

* P ; superphosphate.
** Lar ; large roots.
Sma ; small roots.

for long-term root growth studies at the same place. But there can be problems of plastic effects on root growth(Taylor and Bohm, 1976; Voorhees, 1976), and glass rhizotron windows was recommended in rooting density studies (Taylor and Bohm, 1976).

Ⅳ. SUMMARY

Rhizotron technique was used to determine the zone of active root growth in contrasting field situations.

The distribution of roots with depth showed most root in the 15~30 cm layer with fewer in the 0~15 cm and below 30 cm layer at Lincoln Farm, while root density increased with depth at Winchmore. At Mt Johm (Lake Tekapo) roots were more distributed near soil surface. Root density was increased with fertilizer and irrigation at Mt John. Root number showed the same trends as root length at all regions. Tube method was good for comparative purposes, and for long-term root growth studies at the same place.

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