ABSORPTION AND TRANSLOCATION OF INORGANIC ELEMENTS IN REGENERATED PASTURE CROPS.

Isamu HARADA*

Introduction

The author studied the absorption and translocation of inorganic elements of alfalfa (*Medicago sativa*) and orchardgrass (*Dactylis glomerata*) cultured at fields with normal conditions[1]. Also the organic constituent of these plants, their assimilation and translocation were studied[2].

The difference in character between pasture crops, wheat and rice plants is in the fact that pasture crops require cutting treatment.

It was recently found that the assimilation of regenerated pattern of alfalfa was normal in the initial stage of growth, but with maturity a decrease caused by increase of respiration with higher temperature was noted.

On the other hand, in orchardgrass, the ear was developed only in spring, while in other periods, growth of leafblade was repeated by cutting;

Thus far, studies of absorption and translocation of inorganic elements in the regenerated pasture crop stages, however, have not been made in Japan, and therefore, the author started to study these problems with the following material and method.

Material and Method

Field condition and cultivation methods for this study.

Experimental fields at the College of Dairy Agriculture were used. Properties of these soils were shown as follows:

pH value with extracted N-KCI was 5.9. Exchangeable CaO, MgO and K_2O were 142.8, 30.3 and 25.0 mg/100 g dry soil. K_2O was found insufficient, so K_2SO_4 and stable manure were added.

The rows for cultivation were 35 cm, amounts of seeds were 20 Kg/ha in alfalfa, and 15 Kg in orchardgrass.

Fertilizers used were 50 Kg as N of $(NH_4)_2SO_4$ and urea; 20 Kg as P_2O_5 (superphosophorus); 50 Kg/ha as K_2O (Potassium sulfate).

Seeds were sowed on May 1st, and the first cutting was made on July 25th for alfalfa and on August 15th for orchardgrass.

After cutting, as shown on table 1, samples were taken in all stages of growth.

* The College of Dairy Agriculture, Nopporo, Hokkaido, Japan.
Jour. Coll. Dairy Agriculture, Vol. 2, No. 1, 1964.

In this paper, the regenerated process between the first and second cutting stage was reported.

Result and Discussion

1) Growth pattern in regenerated plants.

Regenerated pattern in alfalfa and orchardgrass are shown on table 1 a and b.

In alfalfa, regenerated stages were divided into 5 stages and in orchardgrass 6 stages. Regenerated stages in both plants were not found to be similar to the first cutting in the early stages of regeneration, but after the autonomic-regeneration stage they were similar to the first cutting.

2) Fresh and dry weight of pasture crops.

Alfalfa; fresh and dry weight of pasture crops are shown in table 2 a.

After cutting the regrowth of the top was rapid and the amount of fresh and dry weight increased up to the early bloom stage, but its rate of increase was moderate in the later regeneration stages. On the other hand, the stubble decreased between the changing stage and the autonomic-regeneration stage, and in root sudden

Table 1. Character of regenerated pasture crops

a. alfalfa

Sample No.	1	2	3	4	5
Days after cutting	5	10	15	25	35
Growth stage	hetero-regeneration stage	changing stage	autonomic-regeneration stage (bud stage)	early bloom stage	middle bloom stage
Character of growth	Leaf is light green and absorption of nutrients is dependent on original plant.	Leaf becomes green and very elyngate.	Bud developed.	Bloom, and plant height is about 50 cm	Blooming non elongation.

b. Orchardgras

Sample No.	1	2	3	4	5	6
Days after cutting	5	10	15	20	30	40
Growth stage	hetero-regeneration stage	changing stage	autonomic-regeneration stage	elongation stage	repleted stage	leaf-blade early-refracting stage
Character of growth	Leaf is light green, and absorption of nutrients is dependent on original plant.	Leaf becomes green, and very elongate.	Absorption of nutrients is active.	Plant height is 40~50 cm and very elongate.	Leaf-blade becomes wide and replete.	Leaf-blades refract in this stage.

Table 2 a. Growth pattern in regenereted alfalfa

Sample No.		0	1	2	3	4	5
Growth stage		middle bloom stage (cutting stage)	hetero-regenera-tion stage	changing stage	autonomic-regenera-tion stage (bud stage)	early bloom stage	middle bloom stage
Plant height and root length (cm)	Top**	68.0	8.5	28.0	40.5	53.2	62.5
	Stubble*	7~8	7~8	7~8	7~8	7~8	7~8
	Root	26.0	26.3	26.3	28.3	27.3	25.0
Fresh weight (t/ha)	Top	21.55	1.80	7.69	10.64	12.44	12.53
	Stubble	3.29	3.26	3.17	3.23	3.29	3.52
	Root	6.72	5.05	4.86	6.44	6.38	6.29
Dry weight (t/ha)	Top	3.95	0.26	1.09	1.66	2.25	2.57
	Stubble	0.85	0.58	0.70	0.70	0.84	0.89
	Root	1.52	0.95	0.77	1.12	1.38	1.78
Dry matter (%)	Top	18.3	14.2	14.2	15.6	18.1	20.5
	Stubble	25.8	17.8	22.1	21.7	25.4	25.3
	Root	22.6	18.8	15.9	17.4	21.6	28.3

* Stubble in the part 7~8 cm from the soil.

** Top is the part above stubble.

Photo. 1
Alfalfa root 16 days after cutting

Photo. 2
Alfalfa root without cutting

Table 2 b. Growth pattern in regenerated orchardgrass

Sample No.		0	1	2	3	4	5	6
Growth stage		leaf-blade early-refracting stage (cutting s.)	hetero-regen-eration stage	changing stage	autonomic regen-eration stage	elonga-tion stage	repleted stage	leaf-blade early-refracting stage
Plant height and root length (cm)	Top	—	12.0	22.0	35.0	43.0	62.5	78.0
	Stubble	—	7~8	7~8	7~8	7~8	7~8	7~8
	Root	—	30.0	25.0	32.0	27.0	32.0	30.0
Fresh weight (t/ha)	Top	19.72	1.43	4.29	7.87	13.73	16.02	18.05
	Stubble	10.80	8.00	10.60	11.20	10.90	9.20	10.80
	Root	18.30	14.90	12.90	14.30	14.30	22.90	23.00
Dry weight (t/ha)	Top	3.57	0.17	0.50	1.26	1.95	3.02	3.25
	Stubble	1.27	0.85	0.90	1.20	1.20	1.27	1.20
	Root	3.46	2.83	2.32	2.86	2.49	4.00	4.14
Dry matter (%)	Top	18.1	11.9	11.7	16.0	14.2	18.9	18.0
	Stubble	11.8	10.6	8.5	10.7	11.0	13.8	11.1
	Root	18.9	19.0	18.0	20.0	17.4	17.5	18.0

decrease of weights was noted by cutting, and fresh and dry weight became about one-half of cutting stage during the changing stage. This decrease was found also in water cultivated alfalfa[3].

The states of root diminution in alfalfa are shown in photo. 1 and 2.

Orchardgrass: Change of fresh and dry weight by cutting is shown in table 2 b. Dry weight of stubble and root decreased from hetero-regeneration stage to autonomic regeneration stage. F. J. CRIDER[4] found that orchardgrass, smooth bromegrass and toll fescue decreased root activity without exception, when cutting one-half of all top volume of plants. Also D. L. OSWALT, A. R. BERTRAND and M. L. TEEL[5] found that absorption of ^{32}P became slower on cutting plant as compared with non-cutting plant.

3) Content of dry matter in both plants.

Content of dry matter in both plants are shown in table 2 a and b.

Cutting treatment decreased content of dry matter in stubble and top of both plants.

Dry matter of root of alfalfa decreased, but this was not the case

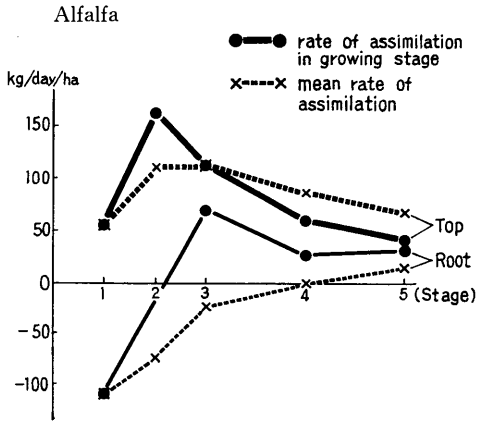

Fig. 1. The rate of assimilation in dry matter production

in root of orchardgrass.

4) Rate and mean rate of assimilation in dry matter.

The rate and mean rate of assimilation in dry matter production for regenerated alfalfa is shown in Fig. 1 and 2 for orchardgrass.

The rate of assimilation in dry matter production for regenerated alfalfa showed maximum values in the changing stage, while for regenerated orchardgrass it showed them in the autonomic-regeneration stage. Mean rate of assimilation for dry matter in alfalfa was at maximum in the autonomic-regeneration (bud stage) stage, while for orchardgrass at the repleted stage.

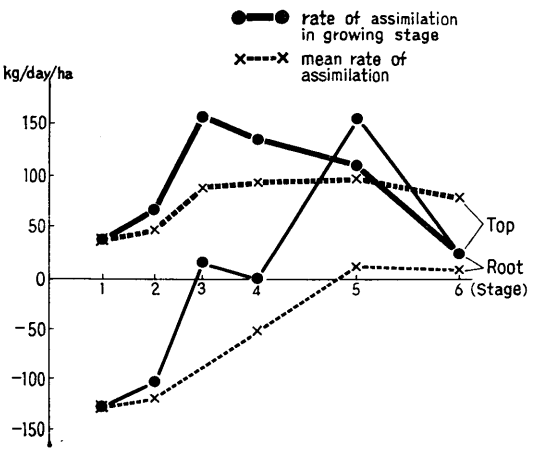

Fig. 2. The rate of assimilation in dry matter production

From these experimental results, the author thinks as follows: The growth and development of perennial crops is a cyclical process in which the plant must be

Table 3 a. Concentration of mineral nutrients Alfalfa (% in dry matter)

Growth stage		middle bloom stage (cutting s.)	hetero-regenaration stage	changing stage	autonomic regeneration stage (bud stage)	early bloom stage	middle bloom stage
N	T	2.88	4.43	4.26	3.92	3.65	3.08
	C	1.71	1.40	1.35	1.44	1.28	1.70
	R	1.59	2.10	1.98	1.88	1.70	1.93
P_2O_5	T	0.44	0.96	0.75	0.70	0.57	0.40
	C	0.48	0.62	0.05	0.11	0.14	0.16
	R	0.62	0.67	0.20	0.21	0.27	0.38
K_2O	T	2.40	3.10	3.10	3.20	3.20	2.30
	C	1.80	2.20	1.70	1.70	1.80	1.50
	R	1.50	1.70	1.80	1.80	1.80	1.00
CaO	T	2.08	1.60	1.60	1.85	1.51	1.50
	C	1.04	1.15	0.89	0.67	0.62	0.50
	R	0.28	0.36	0.51	0.45	0.28	0.27
MgO	T	0.32	0.36	0.32	0 30	0.40	0.32
	C	0.12	0.20	0.32	0.20	0.20	0.12
	R	0.30	0.34	0.32	0.48	0.24	0.30

T···Top, C···Stubble, R···Root

Table 3 b. Concentration of mineral nutrients Orchardgrass (% dry matter)

Growth stage		leaf-blade early-referacting stage (cutting s.)	hetero-regenera-tion stage	changing stage	autonomic regenera-tion stage	elonga-tion stage	repleted stage	reaf-blade-early refracting stage
N	T	2.90	3.99	4.19	3.82	3.40	3.18	2.89
	C	—	1.92	1.85	2.45	1.96	1.82	1.76
	R	—	1.19	1.30	1.04	1.26	1.38	1.34
P_2O_5	T	0.53	0.53	0.52	0.54	0.60	0.48	0.58
	C	—	—	—	—	—	—	—
	R	—	0.27	0.11	0.16	0.10	trace	trace
K_2O	T	4.50	5.00	5.00	5.20	4.60	5.00	4.70
	C	—	4.00	4.00	5.30	4.20	4.50	4.10
	R	—	1.80	1.80	1.60	1.00	1.30	1.10
CaO	T	0.56	0.56	0.45	0.56	0.65	0.56	0.56
	C	—	0.70	0.73	0.70	0.70	0.67	0.66
	R	—	0 56	0.90	0.56	0.58	0.62	0.58
MgO	T	0.32	0.32	0.26	0.32	0.40	0.40	0.32
	C	—	0.36	0.36	0.36	0.34	0.32	0.34
	R	—	—	—	—	0.34	—	—

adequately replenished with nutrients between successive harvests. Otherwise, the stand becomes progressively weaker and less productive.

5) Concentration of mineral nutrients in both plants.

Concentration of mineral nutrients in alfalfa and orchardgrass is shown in table 3 a and b.

Concentration of nitrogen and phosphorus absorbed by alfalfa after the cutting of top decreased from the hetero-regeneration to the middle bloom stage; that of potassium was kept about constant in every stage.

This decrease of phosphate in top should be related to translocation into glucose-1-phosphate of starch[7], but this fact was not found in water cultured alfalfa.

The concentration of nitrogen in dry matter in orchardgrass decreased from the changing stage to later stages.

Concentration of phosphorous and potasium was about constant in all stages.

The total amount of mineral nutrients absorbed by alfalfa increased from the cutting (middle bloom) stage to the early bloom stage and in the case of orchardgrass nitrogen and potassium increased after the cutting of top to the repleted stage and phosphorous increased in its amount to leaf-blade-early-refracting stage.

Concentration of calcium and magnesium was about constant through all stages.

6) The rate of absorption of nutrients (N, P_2O_5, K_2O and CaO) in all regenerated stages.

The rate of absorption of the mineral nutrients in regenerated stages is shown

Table 4. Amount of mineral nutrients in regenerated pasture crops

a. Alfalfa (Top) (kg/ha)

Growth stage	middle bloom stage (cutting s.)	hetero-regeneration stage	changing stage	autonomic regeneration stage (bud stage)	early-bloom stage	middle bloom stage
N	113.8	11.5	46.4	65.1	82.1	79.2
P_2O_5	17.4	2.5	8.2	11.6	12.8	10.3
K_2O	94.8	8.1	33.8	53.1	72.0	59.1
CaO	82.2	4.2	17.4	30.7	34.0	38.6
MgO	12.6	0.9	3.5	5.0	9.0	6.7

b. Orchardgrass (Top) (kg/ha)

Growth stage	leaf-blade-early refrecting stage (cutting s.)	hetero-regeneration stage	changing stage	autonomic regeneration stage	elongation stage	repleted stage	leaf-blede-earay-refracting stage
N	103.5	6.8	21.0	48.1	66.3	96.0	93.9
P_2O_5	18.9	0.9	2.6	6.8	11.7	14.5	18.9
K_2O	160.7	8.5	25.0	65.5	89.7	151.0	152.8
CaO	19.9	1.0	2.3	7.1	12.7	16.9	18.2
MgO	11.4	0.5	1.3	4.0	7.8	12.1	10.4

Table 5. The rates of absorption of nutrients (N, P_2O_5, K_2O and CaO) in all regenerated stages

a. Alfalfa (kg/day/ha, Top)

Growth stage	middle bloom stage (cutting s.)	hetero-regeneration stage	changing stage	autonomic regeneration stage (bud stage)	early-bloom stage	middle bloom stage
N	—	2.3	7.0	3.7	1.7	−0.3
P_2O_5	—	0.5	1.1	0.7	0.1	−0.3
K_2O	—	1.6	5.1	3.9	1.9	−1.3
CaO	—	0.8	2.6	2.7	0.3	0.5

b. Orchardgrass (kg/day/ha, Top)

Growth stage	leaf-blade-early refracting stage (cutting s.)	hetero-regeneration stage	changing stage	autonomic regenaration stage	elongation stage	repleted stage	leaf-blade-early-refracting stage
N	—	1.4	2.8	5.4	3.6	3.0	−0.2
P_2O_5	—	0.2	0.3	0.8	1.0	0.3	0.4
K_2O	—	1.7	3.3	8.1	4.8	6.1	0.2
CaO	—	0.2	0.2	1.0	1.1	0.4	0.1

in table 5a and b.

The rate of absorption of nutrients (N, P_2O_5, K_2O and CaO) in regenerated stages was moderate in the earlier stages and reached their highest absorption peak at the changing stage for alfalfa, and the autonomic-regeneration stage to the elongate stage for orchardgrass.

In the later regeneretion stages, the rate of absorption became moderate again.

Summary

Alfalfa and orchardgrass were cultivated in normal field conditions, and after the first cutting both plants were regenerated. The regeneration was divided into five stages for alfalfa and six stages for orchardgarss.

Analysis of main inorganic elements in these plants was carried out and the results obtained were summarized as follows:

1) The dry matter of top, stubble and root in growing stages of both plants was significantly affected by the cutting. Especially, it showed lowest values on roots of alfalfa at the changing stage and of orchardgrass in between the changing stage and elongation stage.

2) The rate of assimilation in dry matter production for regenerated alfalfa showed maximum values in the changing stage; for regenerated orchardgrass they were found in the autonomic-regeneration stage. Mean rate of assimilation for dry matter in alfalfa was at maximum at the autonomic-regeneration (bud stage) stage, while for orchardgrass at the repleted stage.

3) Concentrations of nitrogen and phosphorous absorbed by alfalfa after the cutting of top decreased from the hetero-regeneration to the middle bloom stage; that of potassium was kept about constant in all stages.

The concentration of nitrogen in dry matter in orchardgrass decreased from the changing stage to the later stage.

Concentrations of phosphorous and potassium were about constant in all stages.

The total amounts of mineral nutrient absorded by alfalfa increased from the cutting (middle bloom) stage to the early bloom stage and in the case of orchardgrass nitrogen and potassium increased after the cutting of top to the replete stage and phosphorous increased in its amount to the leaf-blade-early-refracting stage.

4) The rates of absorption of nutrients (N, P_2O_5, K_2O and CaO) in regenerated stages were moderate in the earlier stage and reached their highest absorption peak at the changing stage for alfalfa, and from the autonomic-regeneration stage to the elongate stage for orchardgrass. In the later regeneration stage, the rate of absorption became moderate again.

Acknowledgements

The author wishes to express his hearty thanks to Professors Y. ISHIZUKA and S. SASAKI and to Dr. Makoto HIURA for their valuable criticism and advice.

References

1) HARADA, I.: *J. Sci. Soil Manure, Japan* **35**, 1 (1964).
2) HARADA, I.: *J. Sci. Soil Manure, Japan* **35**, 5 (1964).
3) Unpublished MS.
4) CRIDER, F. J.: U. S. D. A (1955).
5) OSWALT, D. L., BERTRAND, S. R. and TEEL, M. L.: *Soil. Sci. Soc. Am. Proc.*, **23**, 228 (1959).
6) Unpublished MS.
7) GREEN, D. E. and STAMPF. P. K.: *J. Biol. Chem.*, **142**, 355 (1942).