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NITROGEN MINERALIZATION IN FOREST PEAT SOIL AFFECTED BY ADDITION OF LABELLED ^{15}N FERTILIZER NITROGEN**

INTRODUCTION

Nitrogen is the most frequent nuitrent element in a forest eco — system and at the same time very often a limiting factor of growth of forest trees in conditions of Scandinavian climate. (T a m m, 1961). In a forest fertilization nitrogen is used almost exclusively as a fertilizer of terrestrial soils (H o l m e n, 1971). That fact focuses the relation of immobilization — mineralization of nitrogen. Net mineralization of nitrogen from organic matter in soil through microbiological processes is the most important source of nitrogen for higher plants — forest trees.

Nitrogen mineralization depends, along with other factors (temperature, humidity), very much on C/N ratio (H a r m s e n et al., 1955, Z ö t t l, 1960, V l a s s a k, 1970). Addition of nitrogen fertilizers to soil has no outstanding effect upon nitrogen mineralization, according to some authors (A l e k s i ć et al., 1967, Z ö t t l, 1960) or can even have a negative effect, called by Z ö t t l (1960) »nitrate effect«. But the same author allows for possibility of positive effect of added nitrogen (and nitrate) fertilizer in cases where humus i. e. organic matter is very poor in nitrogen and rich in energy sources. Contrary to that, according to other authors, it is possible to expect a strong stimulative effect upon the general process of nitrogen mineralization.

B r o a d b e n t (1948, 1965) who called this »Priming effect«. J a n s s o n (1958) believes that liberation of nitrogen from organic matter of soil induced by addition of fertilizers is an »artifact« which can be expla-

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ined on the basis of exchange between labelled ^{15}N from the fertilizer and a much larger quantity of nonlabelled organic nitrogen. Overrein (1967, 1970) found that addition of nitrogen fertilizer to raw humus under suitable conditions of the environment has a stimulating effect on the mineralization of nitrogen from humus, where temperature, along with varying quantity of nitrogen fertilizers, is of particular importance.

This paper will present the results of an experiment with addition of ^{15}N — labelled ammonium-sulfate and calcium-nitrate to peat with varying C/N ratio, in an incubation experiment.

MATERIAL AND METHODS

Material for this incubation experiment was gathered systematically taken samples with an auger of diametar 7 cm, 18 individual samples for one general sample from three areas on peat land.

Rik　sten, 20 km south of Stockholm, with Sphagnum-peat where there is a very low growing stand of Scots pine (mean annual increment 1 m^3/ha). The analytical results (Table 1) show that it is peat with very low contents of total nitrogen and a high C/N ratio, very acidic reaction and poorly humified.

Jägarmossen, 60 km north of Stockholm, »fen« peat fairly well humified, with spruce forest with the mean annual increment of 7—8 m^3/ha. The analytical results in Table 1 show that peat is far richer in nitrogen (2% N), with a considerably narrower C/N ratio.

Kilsmo, 200 km south of Stockholm, »fen« peat with a forest of spruce and birch trees with very low increment (ca 2 m^3/ha), very well humified, and judging from the results in Table 1, very rich in nitrogen.

All the three experimental fields were drained some 30—40 years ago, and earlier.

Peat was taken from a layer 0—10 cm and 11—20 cm, the material was not dried. It was sifted through a sieve of 3 mm and kept in a refrigirator in the course of manipulation till the beginning of incubation. Since Sphagnum peat could not be sifted, it was cut, with a special machine, into pieces of up to 3 mm. Roots, with diametar larger than 2 mm were first cut off from all samples.

For the incubation we took quantities of 40 gr. of fresh peat (about 10 gr of dry matter) and placed them into. Erlenmayer flasks of 300 ccm, whic were then sealed with a plastic cover 50 micrones thick in order to preserve humidity (Popović, 1967). Prior to that, humidity was set at 60% of the maximum water capacity.

Incubation was conducted in a dark chamber at constant temperature of 20 °C and relative air humidity of 70—80%. The incubation lasted for 10 weeks and samples for analyses were taken at intervals of two weeks.

In order to determine NH_4-N and NO_3-N, an extract of 1% $KA_1(SO_4)_2$ was prepared by shaking it on a rotation machine with 200 ml of solution for 1 hour. Before shaking, the solution was regulated at pH 6.0—6.5 by addition of $Ca(OH)_2$ in powder.

Table 1.

DATA ON SOME CHEMICAL PROPERTIES OF THE PEAT APPLIED IN THE INCUBATION EXPERIMENT USING ^{15}N — LABELED NITROGEN FERTILIZERS

NEKA HEMIJSKA SVOJSTVA TRESETA UPOTREBLJENOG ZA INKUBACIONI OGLED SA PRIMJENOM ^{15}N MARKIRANOG AZOTNOG ĐUBRIVA

Locality / Lokalitet	pH H_2O	Loss on ignition / Gubitak žarenja	C % d. w.	N % Kjeld.	C/N	P mg/100 g			K mg/100 g			Ca mg/100 g		
						AL—	HCl—	Tot.	AL—	HCl—	Tot.	AL—	HCl—	Tot.
Layer-Sloj, 0—10 cm														
Riksten	3,7	97,2	49,0	1,03	48	9	24	63	20	23	33	—	—	1070
Jägarmossen	4,0	94,9	46,2	1,92	24	10	27	65	58	58	77	76	204	259
Kilsmö	4,6	84,3	41,0	2,95	14	3	26	110	16	20	46	360	1180	—
Layer-Sloj, 11—20 cm														
Riksten	3,8	97,6	47,0	0,92	51	5	21	48	25	24	41	70	200	252
Jägarmossen	3,8	94,3	46,8	1,62	29	—	—	—	—	—	—	—	—	—
Kilsmö	4,7	93,1	46,5	2,84	16	2	18	94	8	20	39	370	1180	—

Table 2.

TOTAL INORGANIC NITROGEN IN PEAT SAMPLES, PER CENT OF KJELDAHL — , AFTER VARIOUS PERIOD OF INCUBATION UP TO 10 WEEKS

TOTALNI NEORGANSKI AZOT U UZORCIMA TRESETA IZRAŽEN U PROCENTU OD UKUPNOG AZOTA (KJELDAHL — N) NAKON RAZLIČITOG TRAJANJA INKUBACIJE (DO 10 NEDJELJA)

Locality Lokalitet	Treatment Tretman	Incubation period, weeks — Period inkubacije, nedjelja					
		0	2	4	6	8	10
		Layer — Sloj, 0—10 cm					
Riksten	control	0,53	0,35	0,21	0,92	0,75	1,47
„	NH_4—	4,01	0,90	3,94	5,32	5,27	6,01
„	NO_3—	5,24	4,99	6,21	6,84	7,13	7,40
Jägarmossen	control	0,24	0,27	0,48	0,82	1,40	1,33
„	NH_4	0,89	0,80	1,10	1,30	1,98	2,18
Kilsmö	control	1,02	1,45	1,76	2,25	2,44	3,04
„	NH_4—	1,56	1,79	2,27	2,78	2,98	3,63
„	NO_3—	1,63	2,12	2,24	2,84	3,04	3,87
		Layer — Sloj, 11—20 cm					
Riksten	control	0,85	1,15	1,08	1,41	1,61	1,50
„	NH_4—	3,74	3,65	4,35	5,25	4,90	5,47
„	NO_3—	6,08	6,72	8,46	8,55	8,97	8,82
Jägarmossen	control	0,09	0,14	0,21	0,26	0,36	0,37
„	NH_4—	1,09	0,94	1,07	0,87	1,34	1,24
Kilsmö	control	0,91	1,22	1,39	1,53	1,66	2,11
„	NH_4—	1,74	1,78	2,12	2,38	2,47	3,30
„	NO_3—	1,85	1,78	2,19	2,20	2,66	3,29

After filtering, a colourless solution was obtained in which first total NH_4-N was determined by distillation with Na-borate (pH 8.8) and titration, and afterwards in the residue NO_3-N by reduction with Devarda's alloy.

Measurement of isotope ^{15}N presence was done on LKB-9000 Gas Chromatograph — Masspectrometer with additional equipment for isotope analyses.

Total nitrogen was determined after Kjeldahl method (with addition of salicylic acid in order to include NO_3).

The pH was measured electrometrically in water suspension, and loss on ignition by combustion 2 1/2 hours at 580 °C.

Carbon was determined according to the wet combustion procedure by Nömmik (1971).

Ammonium lactate acetic acid and HCl soluble phosphorus, potassium and calcium was determined after the method Egner, Riehm and Domingo (1960).

Total phosphorus, kalium and calcium by boiling in nitric and perchloric acid.

Peat treatment before the incubation with nitrogen fertilizer was done with the following kinds and doses:
Ammonium nitrogen: amonium sulfate with 7.82 atomic % ^{15}N exc.
Nitrate nitrogen: calcium-nitrate with 17.75 atomic % ^{15}N exc.

The dose for the layer of 0—10 cm was 230—510 ppmN and for the layer 11—20 cm 125—500 ppmN. Dose variation was conditioned by different sample humidity.

RESULTS AND DISCUSSION

In principle, there are two methods of qantitative determination of the amount of fertilizer nitrogen present in the soil. The first method includes determination of inorganic nitrogen quantity in treated and untreated soil. The difference in nitrogen contents of fertilized and unfertilized soil consigered to originate from the fertilizer. This method of »difference« is based upon a supposition that the added nitrogen is not immobilized (changed into organic form in soil) and that the treatment with a nitrogen fertilizer did not influence (did not have any effect) upon net mineralization of the native nitrogen in soil. But these conditions are seldom fulfilled (Nömmik, 1968, Popović — Nömmik, 1972). The other method is based upon the use of a nitrogen source marked by an isotope which can be easily determined and followed.

The results of the experiment with addition of ammonium sulfate and calcium-nitrate marked with isotopic ^{15}N to peat with very low nitrogen contents (Figs. 1, 1a, 2 and 2a) show a very intensive immobilization of the added ammonium nitrogen, especially for the layer of 0—10 cm but after only 4 weeks of incubation, there occurs the period of remineralization (Fig. 1) which causes a stronger mineralization of the native nitrogen from peat and therefore we can talk of a highly expressed appearance of »priming effect«. From that point of view there are no important differences between peat from the two investigated layers (Figs. 1 and 2).

If one follows the line of the isotope marked nitrogen, one gets the impression that the remineralization is very low or there is none at all.

Table 3.

NITRATE NITROGEN (NO_3—N) PPM/D. W. IN PEAT SAMPLES AFTER INCUBATION UP TO 10 WEEKS

NITRATNI AZOT (NO_3—N) PPM S. M. U UZORCIMA TRESETA NAKON INKUBACIJE DO 10 NEDJELJA

Locality Lokalitet	Treatment Tretman	Incubation — Period inkubacije, nedjelja period, weeks					
		0	2	4	6	8	10
		Layer — Sloj, 0—10 cm					
Riksten	control	4,9	5,4	6,3	6,3	6,3	6,3
„	NH_4—	4,9	5,4	5,4	5,3	5,4	6,0
„	NO_3—	507,8	307,3	267,4	256,7	252,0	263,1
Jägarmossen	control	0,2	0,3	0,5	0,7	0,9	0,7
„	NH_4—	0,2	0,2	0,6	0,5	0,6	0,8
Kilsmö	control	129,3	175,2	262,8	352,7	395,3	563,5
„	NH_4—	129,3	175,2	269,9	352,7	416,7	489,9
„	NO_3—	311,1	340,9	416,7	575,3	693,7	757,5
		Layer — Sloj, 11—20 cm					
Riksten	control	3,0	4,7	4,5	4,7	4,7	4,7
„	NH_4—	3,0	4,0	4,0	4,0	4,0	4,0
„	NO_3—	506,3	442,7	410,1	409,9	397,7	401,3
Jägarmossen	control	0,3	0,3	0,3	0,6	0,4	0,8
„	NH_4—	0,3	—	0,4	0,5	0,5	1,0
Kilsmö	control	95,4	96,1	97,2	94,2	114,5	120,1
„	NH_4—	95,4	90,6	92,2	102,8	111,3	128,4
„	NO_3—	362,3	339,3	332,3	328,8	302,5	385,3

(Compare Fig. 2). In that case a large quantity of inorganic nitrogen would originate from the organic soil substance, while the largest portion of the added fertilizer would stay immobilized. If we calculate the »priming effect« on the basis of the found marked nitrogen in the treated soil and the contents of inorganic nitrogen in the untreated soil, we get a much more positive result. (Tab. 3 i 4). We must point out that the percentage of the total nitrogen minerilized in this peat was all the time very low in the control samples. In the treated samples the above figures were 4—5 times higher (see Table 2).

Table 4.

CALCULATION OF »PRIMING EFFECT« BY DIFFERENCE METHOD AND ISOTOPE METHOD. INORG. NITROGEN PPM/D. W.

OBRAČUN »PRIMING EFFECT«-A METODOM RAZLIKE I ISOTOPNOM METODOM NEOG. AZOT PPM/S. M.

Locality Lokalitet	Treatment Tretman	Method Metoda	Incubation time, weeks — Vrijeme inkubacije, nedjelja — 2	4	6	8	10
			Layer — Sloj, 0—10 cm				
Riksten	NH_4—	a[+]	—	26	96	107	110
,,		b[+]	31	325	375	404	410
,,	NO_3—	a	—	71	143	125	78
,,		b	192	315	408	—	235
Jägarmossen	NH_4—	a	—	—	—	—	38
,,		b	70	93	60	80	133
Kilsmö	NH_4—	a	—	—	—	—	16
,,		b	1	58	64	70	75
,,	NO_3—	a	—	—	—	—	63
,,		b	—	15	35	44	87
			Layer — Sloj, 11—20 cm				
Riksten	NH_4—	a	—	35	88	37	100
,,		b	98	188	285	200	261
,,	NO_3—	a	45	213	178	182	161
,,		b	165	337	320	334	298
Jägarmossen	NH_4—	a	—	—	—	—	—
,,		b	54	68	49	91	89
Kilsmö	NH_4—	a	—	—	8	—	107
,,		b	2	56	106	104	191
,,	NO_3—	a	—	—	—	19	69
,,		b	—	29	14	105	124

\+ a = difference method (metoda razlike)
b = isotope method (izotopna metoda)

* a = difference method (metoda razlike)
b = isotope method (izotopna metoda)

This effect of the soil organic N of added nitrogen in the mineralization has often been explained as due to different factors, like excange of ions, development of root system, osmotic effect of the added fertillizer and biological interchange (Broadbent, 1965).

The experiment with addition of marked nitrate nitrogen to this peat is of special interest and it proved that there is no nitrification (see Table

Table 5.

CHANGES IN THE RATIO BETWEEN THE LABELLED AND TOTAL INORGANIC NITROGEN DURING INCUBATION EXPERIMENT LABELLED PER CENT N mark OF TOTAL N Neorg.

PROMJENE U ODNOSU IZOTOPOM MARKIRANOG AZOTA PREMA UKUPNOM NEORGANSKOM AZOTU U TOKU INKUBACIJE PROCENT N mark. OD TOTALNOG N Neorg.

Locality and treatment	Layer Sloj	Incubation period, weeks — Period inkubacije, nedjelja					
		0	2	4	6	8	10
Riksten							
$(NH_4)_2SO_4$	0—10 cm	86,7	26,9	14,6	14,4	11,2	9,3
$Ca(NO_3)_2$	„	97,6	57,7	44,1	37,1	—	35,5
$(NH_4)_2SO_4$	11—20 cm	77,3	39,3	28,9	24,7	22,9	20,8
$Ca(NO_3)_2$	„	98,0	69,3	54,4	51,7	47,9	50,6
Jägarmossen							
$(NH_4)_2SO_4$	0—10 cm	72,8	21,0	12,5	9,5	8,1	6,9
„	11—20 cm	92,1	49,8	41,6	27,6	30,8	26,7
Kilsmo							
$(NH_4)_2SO_4$	0—10 cm	34,9	18,8	13,9	11,0	10,2	9,6
$Ca(NO_3)_2$	„	37,8	23,8	18,8	16,5	15,0	13,8
$(NH_4)_2SO_4$	11—20 cm	47,5	30,9	25,2	20,1	18,1	16,0
$Ca(NO_3)_2$	„	50,8	34,7	32,1	28,5	24,2	22,7

3). Immobilization is somewhat lower, while the »priming effect« is only a little lower (Figs. 1a and 2a). If we follow the change of contents of nitrate in the course of incubation on the treated samples, we can see that in spite of a considerable qantity of ammonium nitrogen (after two veeks more than 200 ppm NH_4-N) in peat, a large portion of the added nitrate nitrogen was consumed by microorganisms, so that only 50% of the added quantity was present in NO_3 form at the end of the experiment period. (Table 3), which is in conflict with the idea that in the presence of ammonia nitrate is not consumed by the soil microorganisms (Janson, et al. 1955).

A smaller part of the immobilized NO_3-N^{15} is remineralized and here found in ammonium form (35—45 ppm or 15—20% of the total immobilized NO_3-N). A similar remineralization of the added NO_3-^{15} was observed in the experiment with microplots in a Norway spruce stand (Popović — Nömmik, 1972).

It is interesting to see that the proportion of the isotopic ^{15}N nitrogen in the total inorganic nitrogen fraction keeps decreasing in the course of incubation, which was also noticed by Nömmik (1968), in which case there is clear difference between ammonium and nitrate fertilizers (Table 5).

The experiment of peat incubation with medium level of contents of total nitrogen, which was made only with addition of ammonium-sulfate showed the same but less expressed tendency of nitrogen immobilization from fertilizers at the beginning stage of incubation, while the »priming effect« failed completely to appear when calculated after the method of

»difference« (Figs. 3 and 4). But if it is calculated using the isotope method, the »priming effect« is possible to calculate in the whole course of incubation, with both layers of the investigated peat (see Table 4). Participation of nitrate marked with isotope ^{15}N decreas very much during the period of incubation, which is especially clear in the layer of 0—10 cm. (Table 5).

The experiment concerning peat with a very high degree of contents of total nitrogen and addition of ammonium sulfate and calcium nitrate showed, first of all, a very intensive nitrification even with untreated samples (Table 3) which did not occur with the two previously investigated types of peat. Net mineralization of nitrogen in this peat is, generally speaking, very intensive throughot the incubation period especially in samples taken from the layer of 0—10 cm. (Figs. 5 and 6), and consequently the treatment with ammonium-sulfate i. e. calcium-nitrate did not show any clearer upon nitrogen mineralization. Certain immobilization of both added ammonium-sulfate and calicum-nitrate N can be noticed in both layers in the initial period of incubation (Table 5) which later becomes stable at one level.

Participation of nitrogen in a fertilizer marked with isotope ^{15}N kept decreasing and at the end of the incubation period it was only 9.6% of the total inorganic nitrogen in peat treated with ammonium-sulfate from the layer of 0—10 cm (in the beginning it was 34.9%, see Table 5).

Using the method of »difference«, the »priming effect« almost was not found at all, but the isotope calculation method showed a certain positive effect of the added fertilizer, specially, in the layer of 11—20 cm in the final stage of incubation (Table 4).

A special calculation of isotope ^{15}N marked nitrogen which was done separately for NH_4 — and NO_3 form of nitrate — which is not presented here because of lack of room — showed that the isotope ^{15}N from ammonium-sulfate changed into nitrate form, from 14 ppm even to 62 ppm NO_3-N at the end of incubation period or 39% of the added quantity of ammonium-sulfate. In the calcium-nitrate treatment did not discover any clearer change of NO_3-N^{15} marked nitrogen into NH_4-N form of nitrogen.

SUMMARY

In the incubation experiment with constant temperature and humidity in a dark chamber, it was investigated changes of the added isotope ^{15}N marked ammonium-sulfate and calcium nitrate on three types of forest peat soil with varying contents of the total Kjeldahl-nitrogen.

Incubation lasted for 10 weeks in which samples for analyses taken at intervals of 2 weeks, showed that there is a clear, mostly biological, immobilization of the added mineral nitrogen which is most intensive in peat with low total nitrogen contents. The most intensive immobilization was found after the first two weeks of the incubation, after which began the period of remineralization of nitrogen added.

The added sources of inorganic nitrogen (ammonium-sulfate and calcium-nitrate) acted here more or less positively upon the total nitrogen in organic substance of the investigated peat,

In a majority of the samples so called »priming effect« was found which was expressed in peat with low contents of total nitrogen.

Calculation of this effect which was done after the isotope method produced a considerably higher positive result than calculation using the method of »difference«.

Participation of nitrogen marked with isotope ^{15}N in the total quantity of the determined inorganic nitrogen kept decreasing in the course of incubation and reached its lowest point at the end of the period and ammonium nitrogen showed a much greater decrease than nitrate nitrogen.

Both forms of the added nitrogen proved to be an almost equal source of nitrogen for microorganisms i. e. it was not possible to prove that they preferred NH_4-N in presence of NO_3-N.

The surface layer of peat (0—10 cm) had a more intensive reaction in the course of the incubation experiment than the layer below (11—20 cm).

POPOVIĆ B.

EFEKAT DODAVANJA ^{15}N MARKIRANOG AZOTNOG ĐUBRIVA NA MINERALIZACIJU AZOTA U ŠUMSKOM TRESETNOM TLU

KRATAK SADRŽAJ

Ogledi kratkoročne inkubacije sa uzorcima treseta sa različitim nivoom sadržaja ukupnog azota ca 1,00%, 2,00% i 3,00% N s. m.) bili su sprovedeni u mračnoj komori pri 20 °C i konstantnoj vlažnosti (60% WK). Uzorci treseta su tretirani ^{15}N markiranim amonsulfatom (7,82 atom% ^{15}N u ekcesu) i kalcijumnitratom (17,75 atom % ^{15}N u ekcesu). Primijenjena doza je iznosila 230—300 ppm N za 0—10 cm sloj i 130—500 ppm N za sloj od 11—20 cm.

Inkubacija je vršena u ukupnom trajanju od 10 nedjelja, a uzorci za analizu su uzimani u vremenskim razmacima od 2 nedjelje.

Kod uzoraka treseta sa niskim sadržajem ukupnog azota utvrđena je jaka imobilizacija azota iz dodatog amonsulfata u početnoj fazi inkubacije (nakon dvije nedjelje je bilo cca 60% od dodatog amonsulata imobilizirano).

U daljem toku trajanja inkubacije dio imobiliziranog azota bio je remineraliziran, tako da je dodavanje ^{15}N markiranog amonsulfata prouzrokovalo povećanje mineralizacije nativnog organskog azota iz treseta, tzv. »priming effect«. Udio markiranog azota amonijačnog (NH_4-N) u frakciji ukupnog neorganskog azota indicira biološku međuizmjenu, koja uključuje i supstituciju markiranog NH_4-N sa nemarkiranim azotom u organskoj materiji.

Imobilizacija dodatog nitratnog azota je bila također značajna (oko 50% od dodatog nitratnog azota bilo je utvrđeno u nitratnoj formi na

kraju inkubacije), pa je prouzrokovala i simultanu akumulaciju nemarkiranog amonijačnog azota.

Uzorci treseta sa srednjim sadržajem ukupnog azota pokazali su vrlo slabu imobilizaciju dodatog NH_4-N i »priming-effect« nije utvrđen po »metodi diferencije«, ali je izvjestan »priming effect« bilo moguće utvrditi primjenom izotopne metode.

Uzorci treseta sa vrlo visokim sadržanjem ukupnog azota (3,00% N s. m.) pokazali su skoro nikakvu imobilizaciju kod obje forme primijenjenjenog azotnog đubriva. Mineralizacija azota je bila vrlo intenzivna kod netretiranih uzoraka, tako da tretiranje azotnim đubrivima nije dalo neki zapaženi efekt.

Odnos između markiranog amonijačnog azota, odnosno nitratnog azota i ukupnog amonijačnog odnosno ukupnog nitratnog azota pokazao je tendenciju opadanja sa tokom trajanja inkubacije, i to je izrazito za sva tri tipa istraživanog treseta.

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LEGENDA — LEGEND

Coumon legende for all ilustrations (See Fig. 1—8)
Zajednička legenda za sve ilustracije (vidi Fig. 1—8)

Inorganic N found in treated samples
Neorganski N nađen u tretiranim uzorcima

Inorganic N calculated amount in control samples and added at start
Neorganski N obračunata količina u kontrolnim uzorcima plus dodata na startu

Inorganic N labelled recovered
Neorganski N analizirani, otkriven

Inorganic N found in control samples
Neorganski N nađen u kontrolnim uzorcima

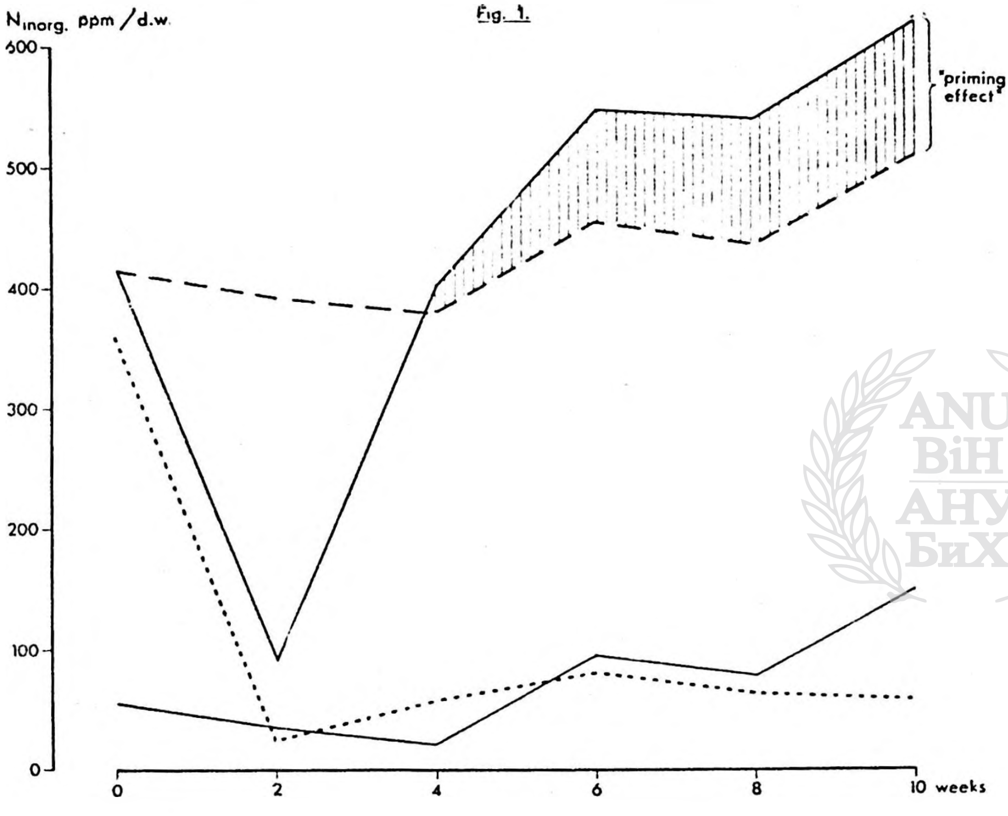

Fig. 1.

Total and labelled inorganic nitrogen in peat samples aster incubation and addition of $(NH_4)_2SO_4$ at start. Riksten, layer 0—10 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije i dodavanja $(NH_4)_2SO_4$ pri startu. Riksten, sloj 0—10 cm.

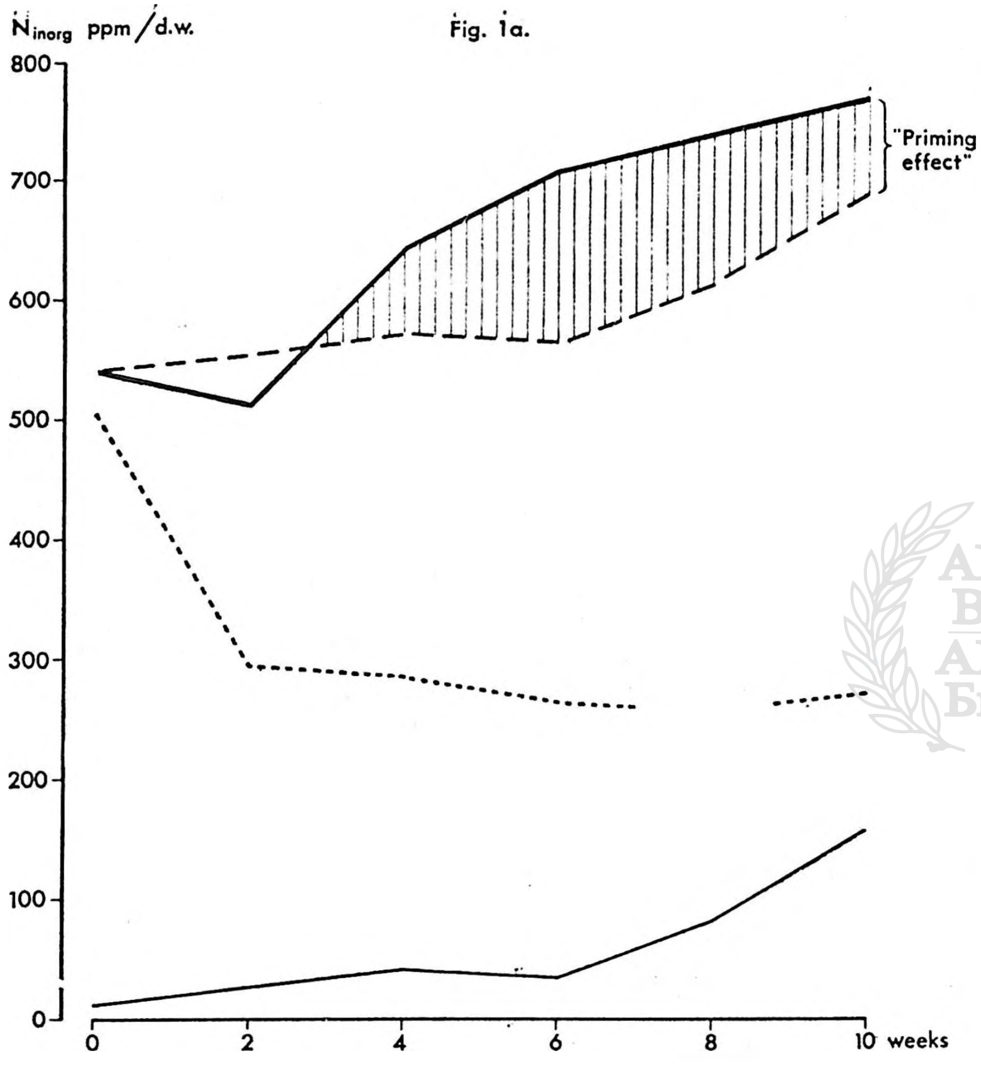

Fig. 1a.

Total and labelled inorganic nitrogen in peat samples after incubation and addition of $Ca(NO_3)_2$ at start. Riksten, layer 0—10 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije sa dodavanjem $Ca(NO_3)_2$ pri startu. Riksten, sloj 0—10 cm.

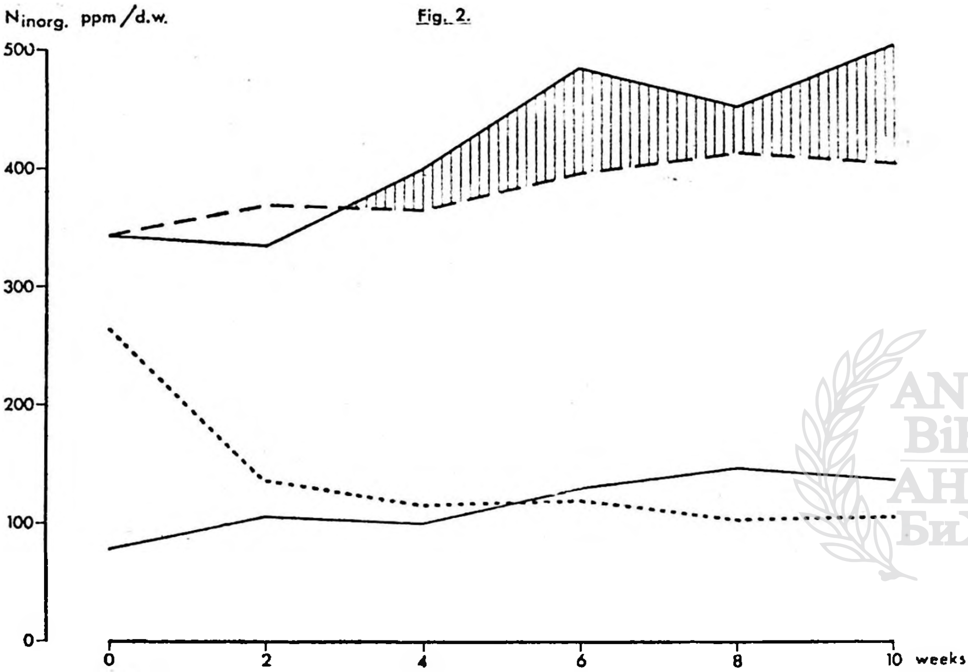

Fig. 2.

Total and labelled inorganic nitrogen in peat samples after incubation and addition of $(NH_4)_2SO_4$ at start. Riksten, layer 11—20 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije i dodavanja $(NH_4)_2SO_4$ pri startu. Riksten, sloj 11—20 cm.

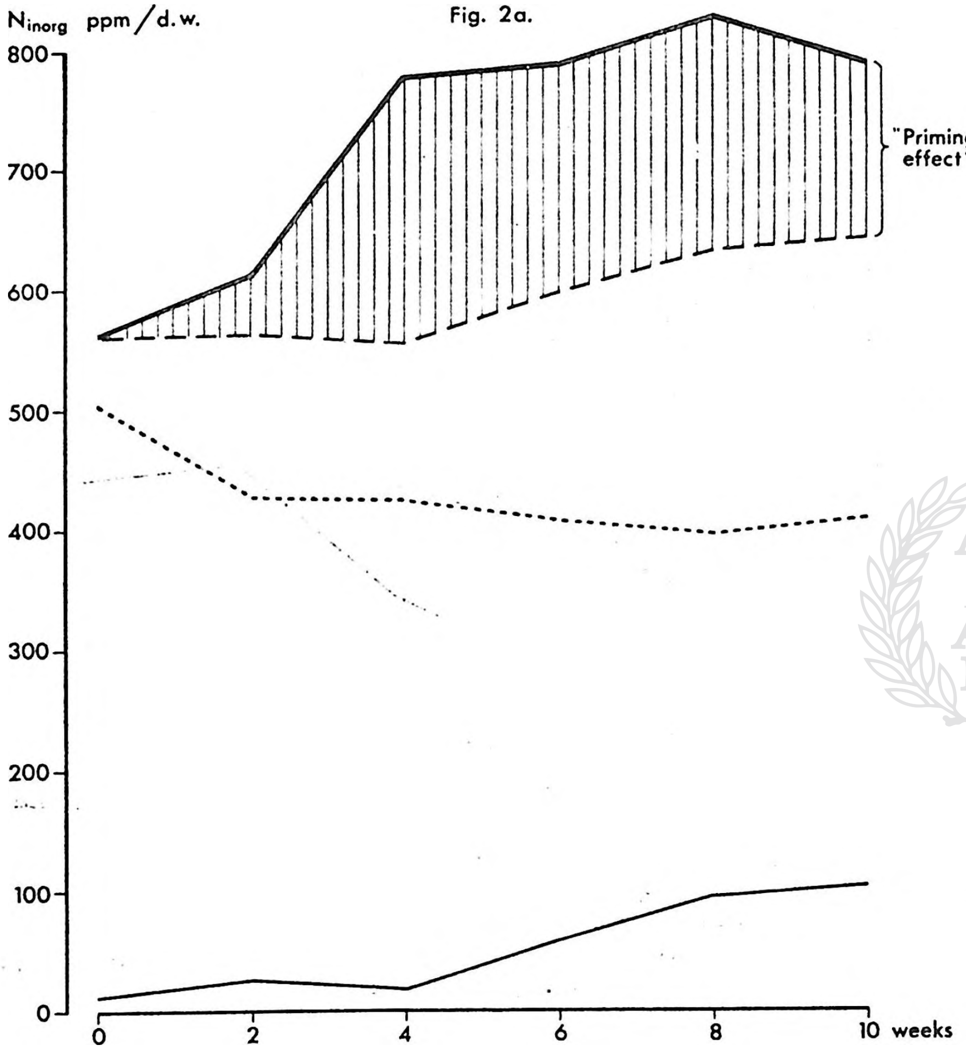

Fig. 2a.

Total and labelled inorganic nitrogen in peat samples after incubation and addition of $Ca(_3)_2$ at start. Riksten, layer 11—20 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije sa dodavanjem $Ca(NO_3)_2$ pri startu. Riksten, sloj 11—20 cm.

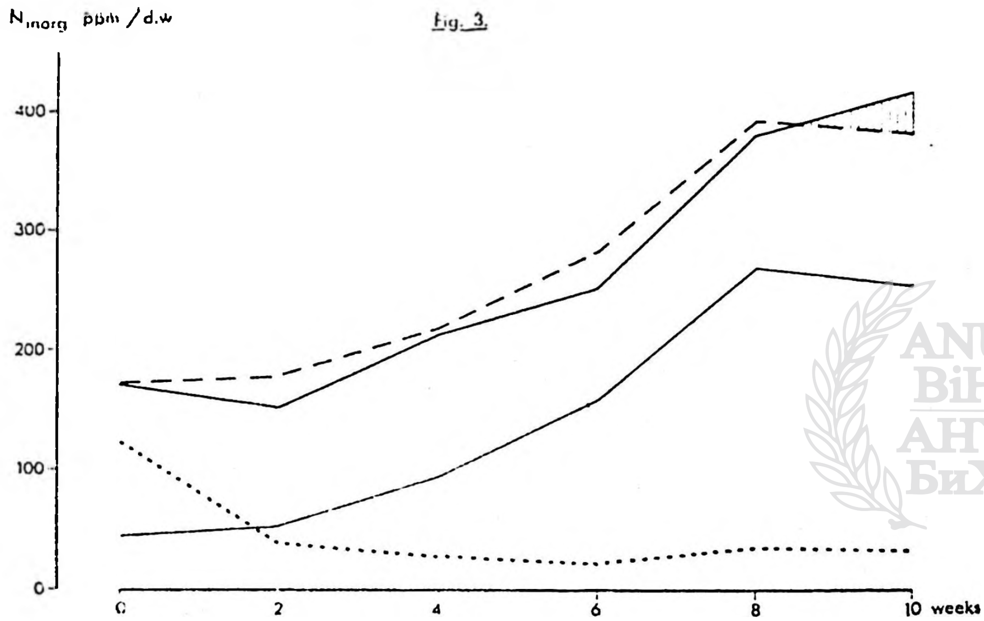

Fig. 3.

Total and labelled inorganic nitrogen in peat samples after incubation and addition of $(NH_4)_2SO_4$ at start. Jägarmossen, layer 0—10 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije i dodavanja $(NH_4)_2SO_4$ pri startu. Jägarmossen, sloj 0—10 cm.

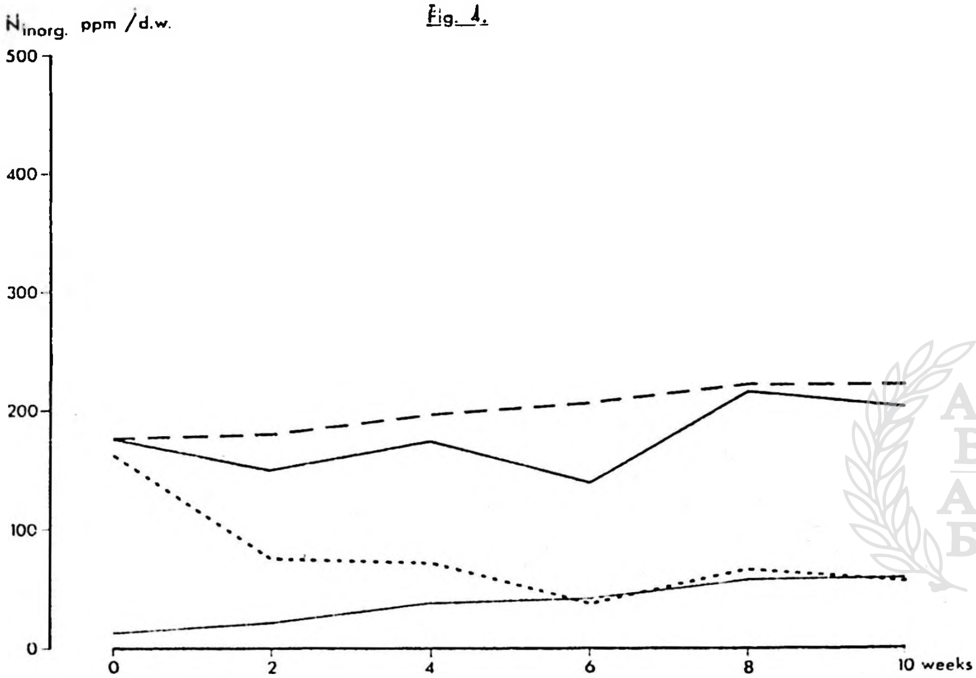

Fig. 4.

Total and labelled inorganic nitrogen in peat samples after incubation and addition of $(NH_4)_2SO_4$ at start. Jägarmossen, layer 11—20 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije i dodavanja $(NH_4)_2SO_4$ pri sratu Jägarmossen, sloj 11—20 cm.

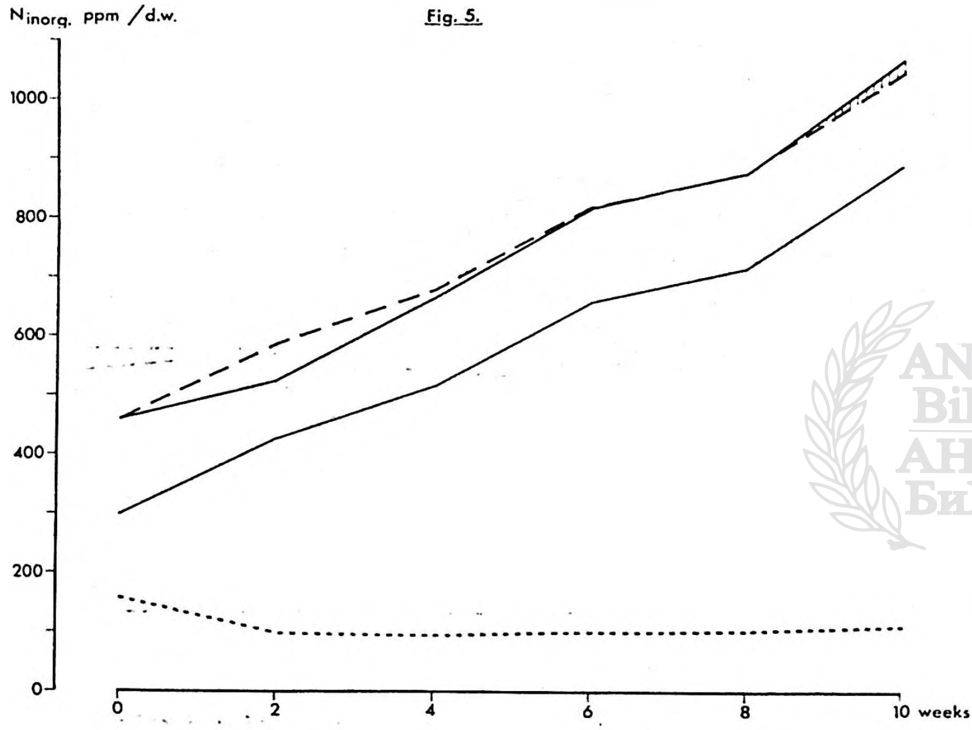

Fig. 5.

Total and labelled inorganic nitrogen in peat samples after incubation and addition of $(NH_4)_2SO_4$ at start. Kilsmo, layer 0—10 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije i dodavanja $(NH_4)_2SO_4$ pri startu. Kilsmo, sloj 0—10 cm.

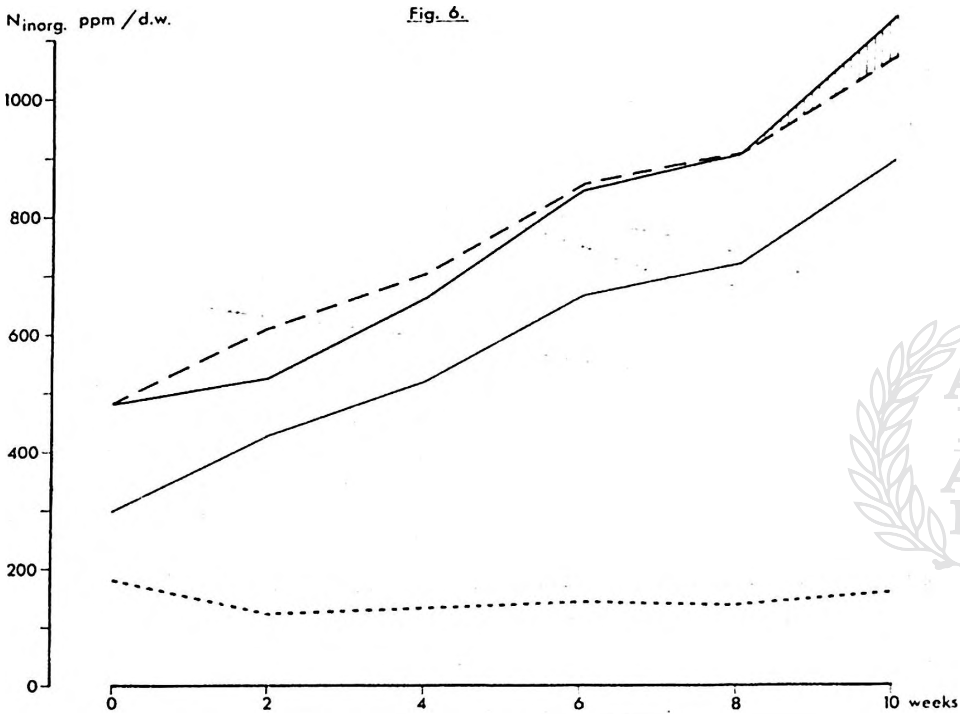

Fig. 6.

Total and labelled inorganic nitrogen in peat samples after incubation and addition of $Ca(NO_3)_2$ at start. Kilsmo, layer 0—10 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije i dodavanja $Ca(NO_3)_2$ pri startu. Kilsmo, sloj 0—10 cm.

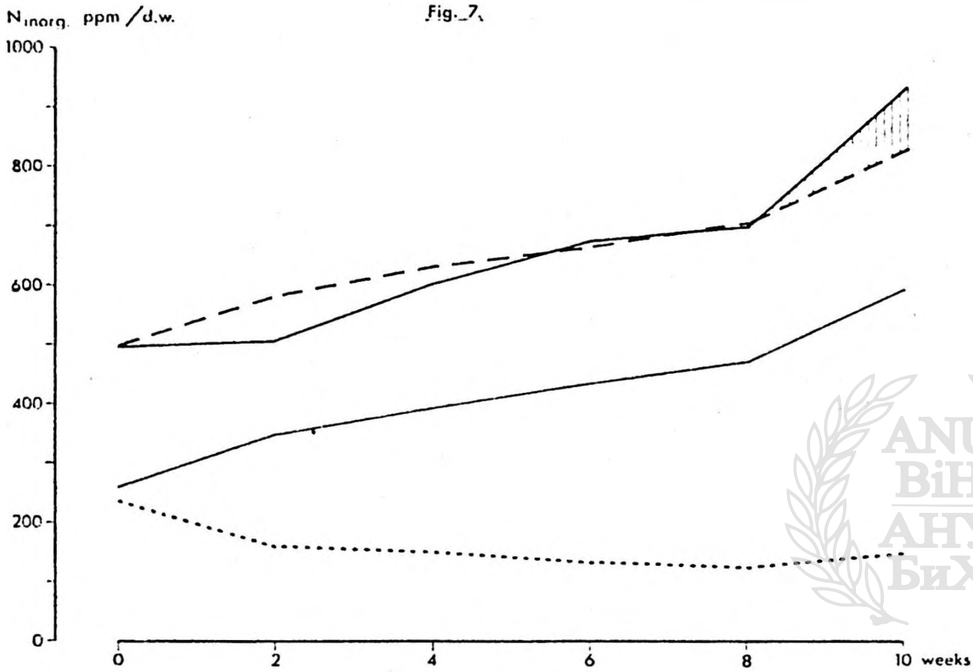

Fig. 7.

Total and labelled inorganic nitrogen in peat samples after incubation and addition of $(NH_4)_2SO_4$ at start. Kilsmo, layer 11—20 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije i dodavanja $(NH_4)_2SO_4$ pri startu. Kilsmo, sloj 11—20 cm.

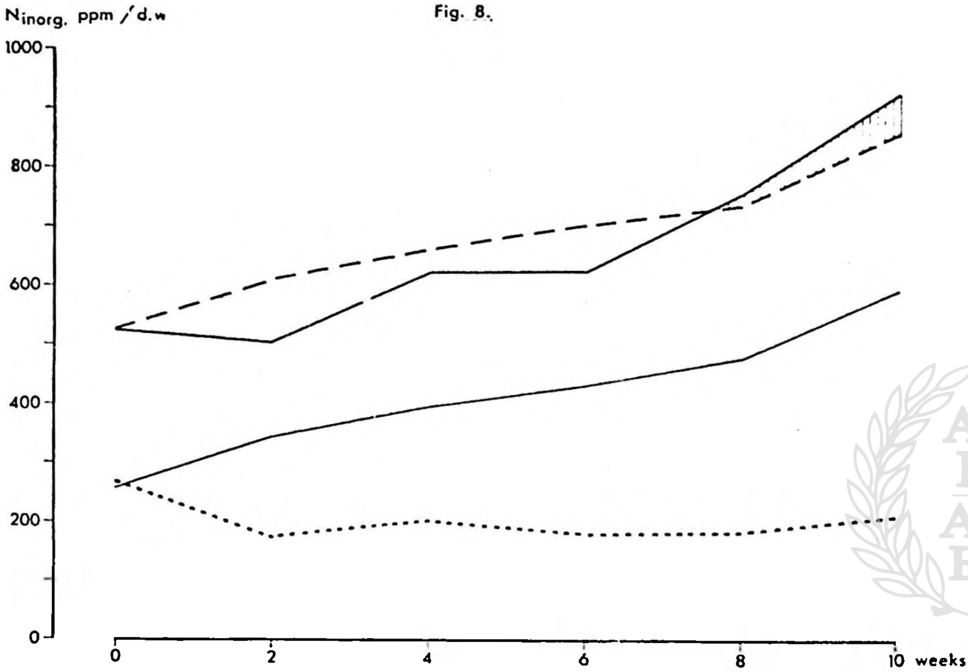

Fig. 8.

Total and labelled inorganic nitrogen in peat samples after incubation and addition of $Ca(NO_3)_2$ at start. Kilsmo, layer 11—20 cm.

Ukupni i izotopom obilježeni neorg. azot u uzorcima treseta nakon inkubacije i dodavanju $Ca(NO_3)_2$ pri startu. Kilsmo, sloj 11—20 cm.