Received April 3, 1974

Influence of rice straw and calcium cyanamide on microbiological activity in two Portuguese alluvial soils

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In Portugal an increasing amount of calcium cyanamide is added directly to the soil. This study had to clarify its effect on the microflora and its activity in the soil.

Two kinds of Portuguese alluvial soils, sandy soil and loamy soil, both originating from areas of intense rice cultivation, were available for the investigation carried ou at Giessen. For control purposes in the investigation on CO_2-production a loess soil from the area around Göttingen (Germany) was used which is known for intense microbiological activity.

There are results from other countries, yet in those experiments other kinds of straw were used. Therefore it seemed reasonable to include wheat straw in this investigation as well.

The rice straw contained 0.275 % of total nitrogen, the wheat straw 0.307 %, and the calcium cyanamide contained 20.66 % ot total nitrogen.

The following table gives some facts about the Portuguese soils.

Kind of soil	T-value m Kal/100 g	S-value soil	H-value	K-value	H-ion concentration
sandy soil	6.0	3.4	2.6	56.7	5.5
loamy soil	22.5	16.4	6.1	72.9	5.7

Kind of soil	calcium requirement in dz/ha	mg P_2O_5 in 100 g soil Egnér-method	mg K_2O in 100 g soil Riehm-Egnér-method
sandy soil	6	16	4
loamy soil	26	2	4

The following investigations were carried out:

1. measurement of H-ion-concentration
2. total count of bacteria used by KOCH and STRUGGER
3. content of active nitrogen
4. CO_2-production of soil by ISERMEYER *
5. Dehydrogenase-activity by THALMANN *

In the experiments the following scheme was used:

Organic manuring			Calcium cyanamide kg N/ha
0	rice straw	wheat straw	0
0	»	»	25
0	»	»	50
0	»	»	100

The amount of straw is comparable to an application of 100 dz/ha. 60 % of the water capacity was used in the experimental containers. The temperature was held at 20 - 22° C, except for those containers to be used for the determination of dehydrogenase activity, those were kept at 25° C. The experiments lasted up to a maximum of 70 days.

* - * Details on the applied methods are to be found in: A. THALMANN: Über die mikroblelle Aktivität und ihre Beziehungen zu Fruchtbarkeitsmerkmalen einiger Ackerböden unter besonderer Berücksichtigung der Dehydrogenaseaktivität (TTC-Reduktion) (On the microbiological activity in relation to fertility characteristics of some soils — special attention given to the Dehydrogenase activity (TTC-reduction).

Agr. Thesis Giessen 1967; Abbreviated version in Zentralbl. für Bakt. II Abt. *124*, 1-55.

Results:

The results are summarized in 24 tables and 9 graphs which are available on request from the Institut für landwirtschaftliche Mikrobiologie der Justus Liebig-Universität, 63 Giessen/Lahn, Landgraf Philipp-Platz 4.

1. Both Portuguese soils show only slight variation in H-ion concentration. The application of calcium cyanamide does not show considerable effects. The decomposition of straw leads in both soils to an increase of the ammonia contents. In sandy soil there is a light correlation between content of ammonia and H-ion concentration which suggests a direct influence on the reaction.

Kind of treatment	H-ion concentration	ammonia content in mg: 100 g soil
sandy soil + rice straw	6.13	11 165
» » » » + 25 kg N/ha	5.85	5 990
» » » » + 50 kg N/ha	5.88	5 953
» » » » + 100 kg N/ha	5.90	6 697
sandy soil + wheat straw	6.31	12 792
» » » » + 25 kg N/ha	6.76	4 615
» » » » + 50 kg N/ha	5.80	5 766
» » » » + 100 kg N/ha	5.93	6 797

In the investigation where loamy soil was used this correspondence was not to be found.

2. To establish the *total count of bacteria* the KOCH-method was applied:

After 30 days in *sandy soil* with both kinds of straw there was a distinct increase to be found. After 70 days we found a heavy decrease in the total amount of bacteria for all conditions except for the non fertilized sandy soil. The decomposition of straw seemed to have ended.

In loamy soil both kinds of straw resulted in an increase of the KOCH count of bacteria after 27 days as compared to the nonfertilized soil, yet, in opposition to the sandy soil there was an even further increase after 70 days. This leads to the conclusion that the process of decomposition of straw is delayed in heavy soil.

In both soils there was a slightly higher increase in the total count of bacteria after addition of wheat straw after

27 resp. 30 days. Therefore wheat straw seems to be more susceptible to microbial decomposition than rice straw. This interpretation is supported by the fact that the total count of bacteria was already reduced 70 days after the sandy soil had been treated with wheat straw.

Finally the count of actinomycetes and molds was determined and in loamy soil of the cellulose decomposers. Except for the molds in loamy soil all numbers showed an increase, in particular the number of cellulose decomposers after treatment with straw. Only for the cellulose decomposers there was a higher number to be found after addition of wheat straw as compared to rice straw.

There was no difference to be found in the single data as far as the effect of calcium cyanamide is concerned neither in the containers with straw nor in the containers without straw, therefore average means were determined.

Total count of bacteria (KOCH) million/g

Treatment	Sandy soil		Loamy soil	
	after 30 days	after 70 days	after 27 days	after 70 days
Unfertilized soil	5.08	9.17	3.57	3.26
Soil + calcium cyanamide	6.27	4.64	3.68	4.97
Soil + rice straw	10.55	9.44	6.59	10.95
Soil + calcium cyanamide + rice straw	13.68	6.78	6.73	8.77
Soil + wheat straw	12.41	6.77	7.32	15.17
Soil + calcium cyanamid + wheat straw	14.30	9.23	7.18	13.99

The following results were found when the STRUGGER-method was applied:

Count of microorganisms (STRUGGER) after 70 day in billions/g

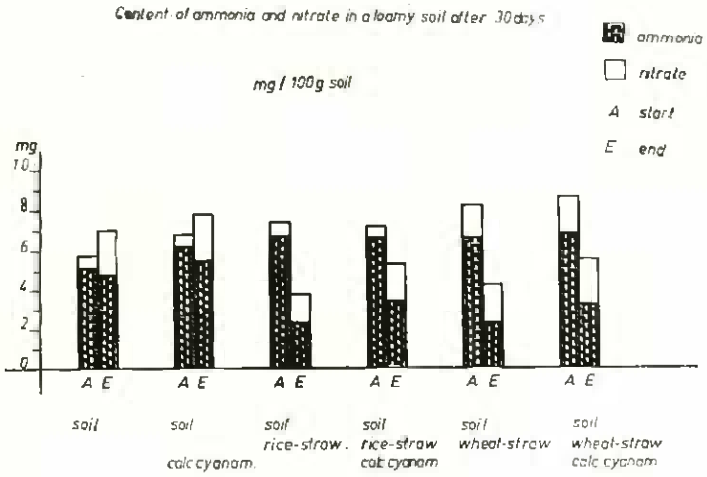
Treatment	Sandy soil	Loamy soil
Unfertilized soil	0.413	2.720
Soil + calcium cyanamide	0.560	3.143
Soil + rice straw	0.366	2.950
Soil + calcium cyanamide + rice straw	0.830	3.277
Soil + wheat straw	0.453	2.898
Soil + calcium cyanamide + wheat straw	0.964	2.271

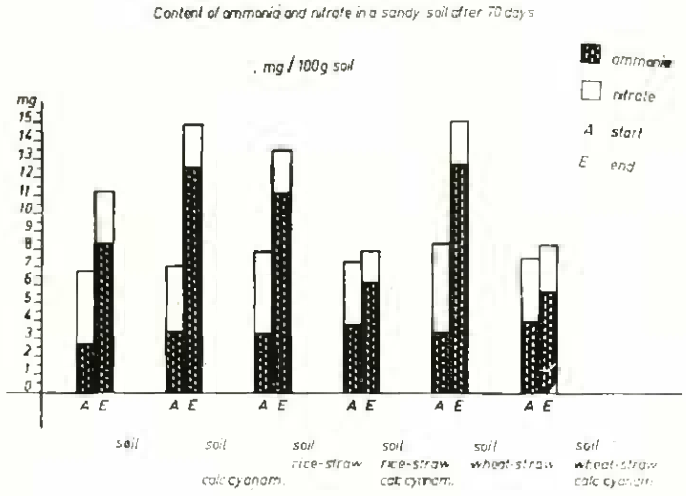
The total count of bacteria — KOCH-method — showed that the calcium cyanamide application resulted in a marked increase in sandy soil after 27 days which was not to be found in loamy soil. An increase after 70 days was only to be found if the STRUGGER-method was used. This is due to the fact that using the STRUGGER-method, the direct count of microorganisms, it remains impossible to differentiate between living and dead organisms, therefore dead organisms are frequently included, whereas in dealing with the KOCH-method living organisms are counted only. After that period of time the maximum number of microorganisms has been reached anyway and it might even be possible that this stadium was reached earlier in soils that had been fertilized with calcium cyanamide than in those treated with straw only.

In the process of decomposition of microbe albumen ammonia is formed which is oxidized to nitrate. These two components, ammonia and nitrate are designated as active nitrogen. As the variations nitrogen application resulted only in very small differences means were calculated.

Soil + Treatment	Loamy soil begin	after 30 days end	Sandy soil begin	after 70 days end
Unfertilized soil	5.750	7.473	6.870	11.325
Soil + calcium cyanamide	6.801	7.833	7.064	14.911
Soil + rice straw	7.340	3.853	7.887	13.453
Soil + calcium cyanamide + rice straw	7.246	5.372	6.424	8.066
Soil + wheat straw	8.192	4.298	8.407	15.049
Soil + calcium cyanamide + wheat straw	8.537	5.537	7.594	8.286

The contents of ammonia and nitrate can be seen in graph N.° 1 and. 2.





In the loamy soil without straw the application of calcium cyanamide has resulted in a slight increase in the ammonia contents, the nitrate-formation had increased during the investigation. The ammonia contents were reduced by the cyanamide which resulted in a slight increase whereas the nitrification showed only a slight decrease with rice straw.

In sandy soil the calcium cyanamide fertilization has lead to about the same increase in the contents of ammonia as the addition of straw, whereas the application of calcium cyanamide plus straw has lead to a marked reduction of the ammonia contents.

The two soils can not be compared directly as the duration of the investigations was different, yet one might assume that in the active sandy soil the large amounts of ammonia which were found after the application of straw were used by the microorganisms and would not be washed out under natural conditions. There were only small differences in the nitrate contents. The largest amount of CO_2 was produced in both unfertilized soils within the first 10 days. In those containers which received straw the CO_2-production lasted longer. The effect after 27 days of the *kind of straw* used is to be seen in the following table:

Treatment	Sandy soil		Loamy soil	
	rice straw	wheat straw	rice straw	wheat straw
Soil + straw	96,46	115,89	118,26	125,98
Soil	47,80	47,80	63,49	63,49
Straw	+ 48,66	+ 68,09	+ 54.79	+ 62,49

The application of straw has led to a marked increase in CO_2-production in both soils and the increase is stronger with wheat straw than with rice straw.

The influence of calcium cyanamide (average of 3 applications) on the respiration of the soil can be seen in the following table (respiration = CO_2-production).

Treatment	mg CO_2 per 100 g soil			
	after 27 days			after 70 days
	sandy soil	loamy soil	loess Göttingen	sandy soil
Soil	47.80	63.49	78.76	69.29
Soil + calcium cyanamide	58.17	66.01	85.76	85.53
Soil + rice straw	96.46	118.28	226.16	136.21
Soil + rice straw + + calcium cyanamide	130.34	122.86	232.68	167.17
Soil + wheat straw	115.89	125.98		167.67
Soil + wheat straw + + calcium cyanamide	170.34	128.37		175.45

In loamy soil after 27 days the CO_2-production is more intense than in sandy soil with two exceptions, but there is still less than in the loess from Göttingen.

To determine the effect of calcium cyanamide we calculated the percentages of increase of CO_2-production as given below:

Treatment	Rates of increase in CO_2-production in % after 27 days			after 70 days
	sandy soil	loamy soil	loess Göttingen	sandy soil
Soil	22	4	9	23
Soil + rice straw	35	4	3	23
Soil + wheat straw	47	2		5

After 27 days the CO_2-production in loamy soil is distinctly higher as compared to sandy soil (63.49 - 47.8) but the rates in CO_2-production due to the treatment with straw is clearly lower in loamy soil (4 - 4 - 2 %) than those in sandy soil (22 - 35 - 47 %).

In loess soil the rates are also lower (9 - 3 %). After 70 days the rate of increase of CO_2-production in sandy soil is far smaller with rice straw (35 - 23 %) and even more pronounced with wheat straw (47 - 5 %). One might assume that the decomposition of wheat straw went faster.

The effect of various applications of calcium cyanamide is given in the following table:

Straw	Calcium cyanamide kg N/ha	*Wheat straw* absolute	*Wheat straw* increase as compared to no N	*Rice straw* absolute	*Rice straw* increase as compared to no N
Sandy soil	+ 0	115.89		96.46	
	+ 25	138.86	+ 22.97	119.67	+ 23.21
	+ 50	133.42	+ 17.53	131.81	+ 35.35
	+ 100	138.74	+ 22.85	139.75	+ 43.29
Loamy soil	+ 0	125.98		118.28	
	+ 25	126.24	+ 0.26	121.03	+ 2.75
	+ 50	132.08	+ 6.10	123.23	+ 4.95
	+ 100	126.80	+ 0.82	124.33	+ 6.05

The figures show that in both soils the increasing amounts of calcium cyanamide resulted in an augmentation of CO_2-production with rice straw only, there was no effect with wheat straw.

If the CO_2-production is taken as a general measure for the presence of microorganisms, there should be a positive relationship beween increase in CO_2-production and increase in the number of micoorganisms.

The figures in the following table confirm this assumption:

Fertilization	*Sandy soil*		*Loamy soil*	
	Count of microorganisms	CO_2-production	Count of microorganisms	CO_2-production
25 kg N/ha	1.04	8.07	— 0.16	— 1.89
50 kg N/ha	1.49	14.69	0.13	3.55
100 kg N/ha	1.03	8.35	0.20	5.90

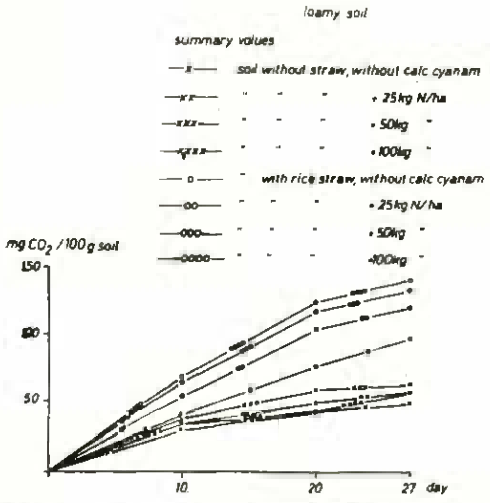
As the CO_2-production showed a marked decrease after 27 days in the soil without straw, we had to investigate whether this tendency would remain or whether there would be another increase. Therefore another experiment was expanded to 70 days. The following table gives the results:

	Total amount of CO_2 in mg per 100 g soil				
	after 30 days		after 70 days		increase after 70 days as compared to 30 days in %
	abs.	rel.	abs.	rel.	
Soil	50.77	100	69.29	100	36
Soil + calcium cyanamide	62.69	113	85.53	123	36
Soil + rice straw	105.46	208	136.21	197	29
Soil + rice straw + calcium cyanamide	136.92	269	167.17	241	22
Soil + wheat straw	124.11	246	167.67	242	35
Soil + wheat straw + calcium cyanamide	143.17	282	175.45	253	23

These figures show that CO_2-production does increase again if the investigation is extended.

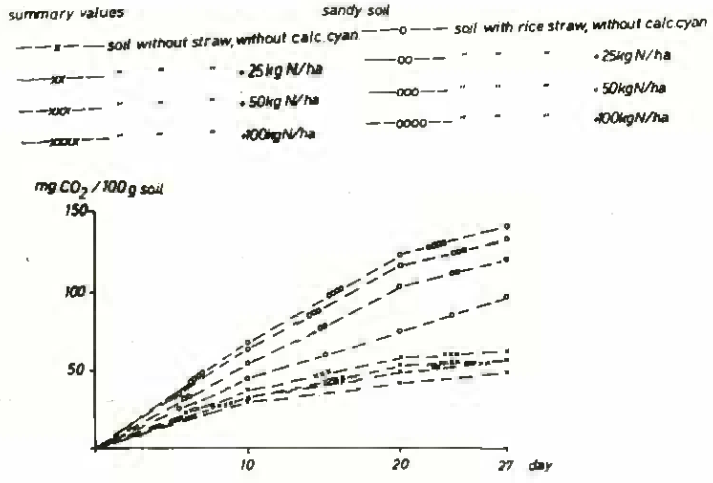
Graphs N.° 3, 4 and 5 show the effect on CO_2-production of the various kinds of treatment in sandy soil and loamy soil.

Graph No. 3: CO_2-production in loamy soil with and without rice straw resp. calcium cyanamide.



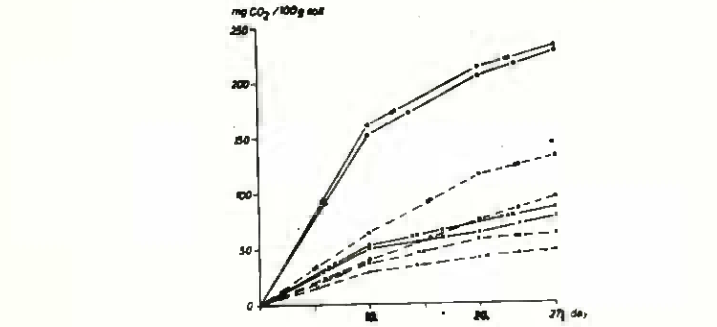
The curves show that in both soils there is a rapid increase first in CO_2production with a tendency to level off later on. This is very articulate in the two soils without straw up to the 20th day, after that period is a certain stagnation.

Graph. No. 4: CO_2-production in sandy soil with and without straw or else calcium cyanamide.



Adding calcium cyanamide resulted in a harmonisation of the differences among rice and wheat straw, that is why the curves show the results of rice straw only. There is an obvious dependency of CO_2-production and the amount of N applied.

Graph No. 5: CO_2-production in Portuguese sandy soil and loess from Göttingen (summarized curve)



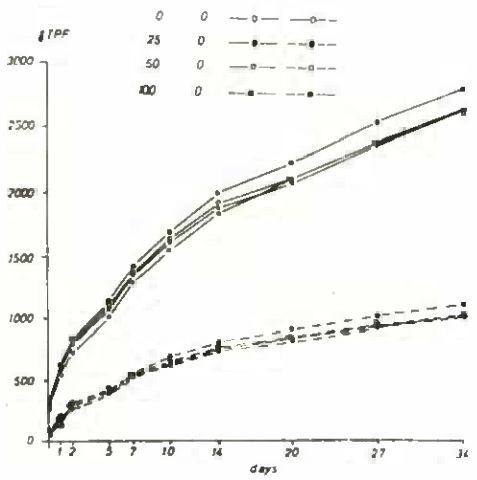
Graph N.° 5 gives the CO_2-production after rice straw application in the Portuguese sandy soil and the loess soil from Göttingen. In the untreated soil there are only minor differences. In sandy soil there is a pronounced effect of straw and in addition to this an even further increase caused by calcium cyanamide. In loess soil the addition of straw resulted in almost a trebling of the respiration, yet calcium cyanamide caused no further increase.

In order to determine the dehydrogenase-activity we had to establish conditions that would not inhibit the activity of the microorganisms by lack of nutrients. Therefore we added P_2O_5 in the form of superphosphate (180 P_2O_5) which correspondents to an amount of 60 k P_2O_5/ha and K_2O in the form of sulphat of potash-magnesium (28 % K_2O) equalling 80 k K_2O/ha before the investigation began.

There is considerable variation among the single data therefore we plotted summarized curves as given in graph N.° 6-9.

Graph N.° 6 shows that the results for dehydrogenase-avtivity are considerably higher in loamy soil than in sandy soil no matter whether calcium cyanamide was added or not. Yet, there is a certain conformity as the data of the 2nd and 34th day are distinctly lower. Trying to explain the decrease of the 2nd day we arrived at the assumption that there might be an inhibition by the calcium cyanamide as RATHSACK found in the process of nitrification. But the decrease was to be found as well in the soils which were not fertilized with calcium cyanamide as well as on the 34th day so there must be an other reason which cannot be explained at the moment.

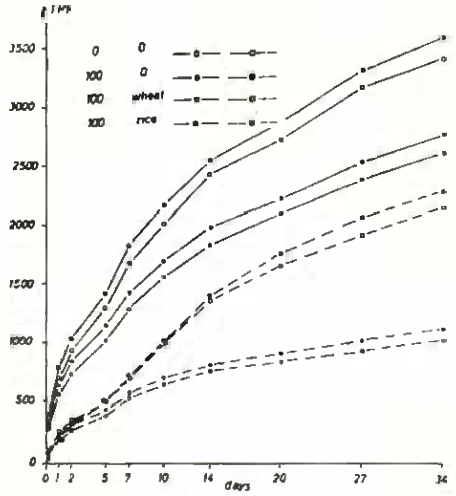
Graph No. 6: Dehydrogenase-activity in loamy and sandy soil with and without calcium cyanamide (summarized curve)



Graph N.° 6 shows that *calcium cyanamide* had a slight effect on the dehydrogenase-activity only if we applied 100 kg N/ha to soil which was not treated with straw.

The effect of the *two kinds of straw* is shown in Graph n.° 7 and n.° 8.

Graph No. 7: Dehydrogenase-activity with or without straw and else calcium cyanamide in loamy and sandy soil (summarized curve)



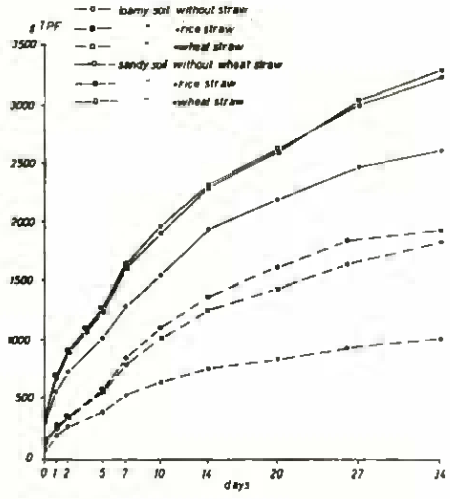
The two kinds of straw resulted in a considerable increase in dehydrogenase-activity. In loamy soil the rice straw is surpassing wheat straw, which in sandy soil is to be found only after the 14th day.

Furthermore it is to be seen that the rate of increase is higher in sandy soil than in loamy soil. This applies also to the number of microorganisms there as well was a higher increase in sandy soil as compared to loamy soil.

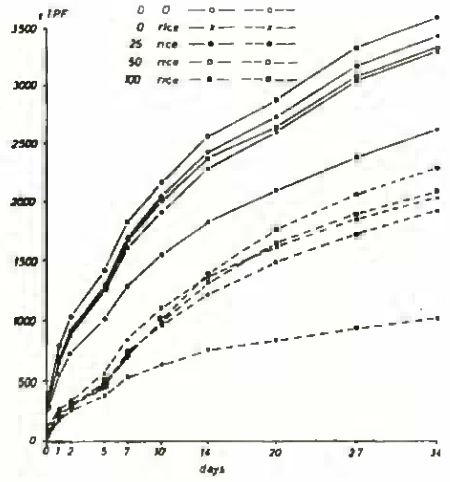
Yet, there are no counts of microorganisms available from the various phases of the investigation; but it is a well established fact that regularly there is a slow phase in the beginning which is followed by a second exponential phase in the increase of microorganisms.

This leads to the assumption that the increase in the dehydrogenase-activity is explained by the increase in the number of microorganisms.

Graph No. 8: Dehydrogenase-activity, the effect of straw only (summarized curve)



Graph No. 9: Dehydrogenase-activity with and without rice straw and calcium cyanamide in loamy and sandy soil (summarized curve)



We only checked out the influence of the various amounts of calcium cyanamide on dehydrogenase-activity with rice straw (see graph n.° 9).

The only unequivocal result is that the application of 100 k N/ha resulted in an increase in the dehydrogenase-activity. In loamy soil there seems to be also a certain increase when 25 and 50 kg N/ha were applied, more pronounced even when 25 kg N/ha were used as compared to 50 kg N/ha. In sandy soil 50 kg N/ha resulted in an increase, whereas 25 kg N/ha led even to an inhibition.

Discussion:

The investigation was designed to find out:

1. the influence of rice straw — applied directly — on the microbiological activity and
2. the influence of an additional fertilization with calcium cyanamide.

As control variable wheat straw was used. As the results were supposed to be relevant for those regions where rice is grown the investigation was carried out on a light sandy soil and a heavy loamy soil from Portugal. Only in one of the series loess from Göttingen (Germany) was used additionally.

The application of straw equalled an amount of 100 dz/ha, the amount of calcium cyanamide was increased from 25, 50 to 100 kg N/ha.

The following results were found:

I. *Number of microorganisms*

1. The number of aerobic microorganisms as used by KOCH was considerably higher after 27 days or else 30 days in the sandy soil than in loamy soil, there was the same effect due to calcium cyanamide fertilisation the rates of increase were also higher in sandy soil.
2. Within the 2nd period (up to the 70th day) we found after a strong decline a phase of balancing, levelling in the amount of microorganisms in sandy soil using the KOCH-method. No influence of treatment was to be found.

In loamy soil we found in all fertilized containers an increase in the amount of microorganisms as compared to the first period (up to 30 days) which even surmounted the total count of microorganisms in sandy soil. The total amount of microorganisms was distinctly higher in those soils without straw. No influence of the N-fertilisation was found.

3. After 70 days the total amount of microorganisms (STRUGGER-method) was higher in the soils treated with calcium cyanamide whether or not they contained straw as compared to unfertilized soils.

II. *Active Nitrogen content*

1. The content of active nitrogen (ammonia and nitrate) had increased after 30 days in the fertilized soils. In all of the manured containers we found a marked decrease, differences lying between 25 and 45 %.
2. After 30 days the content of ammonia in loamy soil showed a decline whereas the content of nitrate had increased.
3. In sandy soil the content of active nitrogen had increased in all but one exception. In all sandy soil containers the amount of ammonia had increased considerably, while the amount of nitrate had diminished.
4. The contents of active nitrogen showed an increase in the two soils without straw at the end of the investigation. Manuring loamy soil with rice or else wheat straw resulted in a strong decline after 30 days, and there is no doubt, that we are dealing with a N-fixation which will result in a lower yield. In sandy soil manuring resulted in an increase in active nitrogen. This might be explained 1. by the fact that sandy soil is more active from a microbiological point of view and 2. the investigation lasted 70 days. At that point the N-fixation seems to have been overcome already. A similar phase difference also was found in the case of fertilisation with calcium cyanamide. After 30 days we found an increase in loamy soil, whereas after 70 days in sandy soil there was a decline again as compared to the containers which were manured with straw only. One might assume that the active nitrogen had been used up. This assumption is supported by the

fact that at that time the total count of living microorganisms (KOCH-method) had diminished while those counted analog to STRUGGER showed a rise.

III. *CO_2-production*

1. Within 27 days the total CO_2-production in loamy soil was higher only in the fertilized containers as compared to sandy soil. After the application of straw the CO_2-production went up considerably, with wheat straw more than with rice straw.
2. Even though if the total amount of CO_2 in both soils did not show a clear superiority of one of the soils, the rates of increase are distinctly higher in sandy soil than in loamy soil.
3. In the loess from Göttingen we found the highest content of CO_2.
4. The rates of increase in CO_2-production caused by the application of calcium cyanamide were larger in sandy soil than in loamy soil or loess. The combination of wheat straw with higher dose of calcium cyanamide did not lead to any further increase in CO_2-production in both soils with only one exception.

   Yet, rice straw combined with higher dose of calcium cyanamide lead to rises in CO_2-production.
5. After 70 days there was still a marked increase in the CO_2--content in sandy soil manured with rice straw, while there was only a minor effect to be found with wheat straw.

   These results and those from the investigation on sandy soil after 30 days show that for both kinds of straw there was only a smaller increase if the containers had been treated with straw and calcium cyanamide as compared to the containers where straw had been applied only. This leads to the conclusion that calcium cyanamide facilitated the decomposition of straw.

IV. *Dehydrogenase-activity*

1. The results showed considerable variation, there was a marked decline on the 2nd and the 24th day which cannot be explained. In loamy soil we found higher rates of dehydrogenase-

-activity than in sandy soil, especially in the beginning of the investigation. Yet, the rates of increase were higher in sandy soil than in loamy soil.

2. The application of straw resulted in a marked increase in dehydrogenase-activity in both soils. There seems to be a superiority of wheat straw as compared to rice straw in sandy soil only.
3. The influence of calcium cyanamide was small. The application of 100 kg N/ha resulted in an increase in both soils. But only in loamy soil the rate of increase corresponded to the amount of fertilizer applied.

One might conclude that the decomposition of both kinds of straw proceeds faster in sandy soil than in loamy soil. The application of calcium cyanamide facilitates the process of decomposition of rice straw in particular. There is reason to conclude that a dose of 25 - 50 kg N/ha are sufficient in general. It seems necessary to add calcium cyanamide to overcome the phase of N-fixation more easily to prevent a damage of the crop. There are some indicators that the decomposition of rice straw is more difficult than the decomposition of wheat straw.

SYNOPSIS

Two Portuguese alluvial soils (sandy and loamy) were used for experiments to investigate the influence of calcium-cyanamide upon the microbiological activity under controlled conditions. To soils no straw, rice straw and wheat straw was added. In some experiments German loess soil was used for comparison. The rice straw contained 0.275 %, the wheat straw 0.307 % total nitrogen, the H-concentration showed pH 5.5 in sandy and pH 5.7 in loamy soil. The application of straw equalled an amount of 100 dz/ha, the amount of calcium-cyanamide was increased from 25 to 50 respectively 100 kg N/ha.

The total count of microorganisms (Koch-method) after 30 days was higher in sandy than in loamy soil, but declined after the 70th day only in the sandy soil. In the loamy soil the count was in the second period higher than in the first period, especially in the containers treated with straw. The content of active nitrogen (ammonia and nitrate) increased after the adition of calcium-cyanamide but

decreased when straw was applied (formation of insoluble organic N-compounds). After 70 days sandy soil again showed an increase of active nitrogen.

The rates of CO^2-production went up considerably after the application of straw, wheat straw was superior to rice straw. The rates of increase in CO^2-production caused by calcium-cyanamide were higher in sandy than in loamy soil or loess. Higher doses of calcium-cyanamide had a positive effect only in the case of rice straw. After 70 days the CO^2-production rose still in containers where rice straw was applied but only a minor effect was found when wheat straw was used. Calcium-cyanamide seems to facilitate the decomposition more of wheat straw than of rice straw and more in sandy than in loamy soil.

The application of straw resulted in a marked increase in the dehydrogenase-activity in both soils but a superiority of wheat straw occurred in sandy soil only. The influence of calcium-cyanamide was small.

The following conclusions seem to be justified. The decomposition of both kinds of straw proceeds faster in sandy than in loamy soil. The process is accelerated by the addition of calcium-cyanamide.

In general doses of 25-50 kg N/ha are sufficient. This treatment seems to reduce the period of the formation of insoluble organic N-compounds which is connected with the application of organic matter with a wide N:C-ratio.

RESUMO

Influência da palha de arroz e da cianamida cálcica na actividade microbiológica em dois aluviossolos portugueses

Usaram-se dois aluviossolos portugueses (um arenoso outro franco) em experiências destinadas a estudar a influência da cianamida cálcica na actividade microbiológica, sob condições controladas. Ensaiaram-se modalidades com palha de arroz, palha de trigo e sem palha. Em algumas experiências utilizou-se para comparação um solo de loess colhido na Alemanha. A palha de arroz continha 0,275 % de N total, a palha de trigo 0,307 % e o pH era de 5,5 no solo arenoso e 5,7 no solo franco. A aplicação de palha equivaleu a 10 000 kg/ha e as quantidades de cianamida foram de 25, 50 e 100 kg N/ha.

O número total de microorganismos (método de Koch) passados 30 dias era mais elevado no solo arenoso que no solo franco, mas, no solo arenoso, diminuiu passados 70 dias. No solo franco aquele número era maior no segundo período que no primeiro, em especial quando se usou palha. O teor em azoto activo (azoto amoniacal e nítrico) aumentou após a adição da cianamida mas diminuiu quando se aplicou palha (formação de compostos orgânicos insolúveis de azoto). Passados 70 dias o solo arenoso acusou de novo um aumento de azoto activo.

As taxas de produção de CO_2 subiram consideravelmente depois da aplicação da palha, mostrando-se a palha de trigo superior à palha de arroz. As taxas de aumento de produção de CO_2 devidas à cianamida cálcica foram maiores no solo arenoso que no solo franco ou loess. A elevação das doses de cianamida só mostrou um efeito positivo no caso da palha de arroz. Passados 70 dias a produção de CO_2 aumentava ainda quando se usou a palha de arroz, mas só se verificou um pequeno aumento para a palha de trigo. A cianamida cálcica parece facilitar mais a decomposição da palha de trigo que a palha de arroz, o mesmo acontecendo em maior escala no solo arenoso que no solo franco.

A aplicação de palha conduziu a um aumento nítido da actividade da dehidrogenase nos dois solos, tendo-se verificado a superioridade da palha de trigo no solo arenoso. A influência da cianamida foi pequena.

Parecem ser possíveis as seguintes conclusões:

A decomposição dos dois tipos de palha usados é mais rápida no solo arenoso que no solo franco sendo o processo acelerado pela adição de cianamida cálcica.

Em geral, doses de 25 a 50 kg N/ha de cianamida são suficientes.

Este tratamento parece reduzir o período de formação de compostos orgânicos de azoto insolúveis, relacionados com a aplicação de matéria orgânica de elevada relação C/N.

ZUSAMMENFASSUNG

Der Einfluss von Reisstroh und Kalkstickstoff auf die mikrobiologische Aktivität von zwei Bodenarten Portugals

In Gefässversuchen mit sandigem und lehmigem Alluvial-Boden wurde der Einfluss von 100 dz/ha Reis- bzw. Weizenstroh in Kombination mit 25, 50 bzw. 100 kg N/ha als Kalkstickstoff untersucht.

Bei einigen Versuchen wurde aus Vergleichsgründen auch Lössboden aus Deutschland verwendet.

Die nach KOCH bestimmte Gesamtzahl der Mikrooorganismen war nach 30 Tagen im Sandboden grösser als im Lehmboden. Im weiteren Verlauf bis nach 70 Tagen nahm die Gezamtzahl im Sandboden abstreg aber im Lehmboden besonders in den Gefässen mit Stroh an.

Der Gehalt an löslichem N (Ammonium und Nitrat) nahm nach Kalkstickstoffgabe zu, verringerte sich aber nach Strohzugabe (Bildung unlöslicher organischer N-Verbindungen). Nach 70 Tagen zeigte sich wiederum im Sandboden eine Zunahme des löslichen Stickstoffs.

Die CO_2-Entwicklung stieg nach Strohzugabe beträchtlich, und zwar mehr bei Weizenstroh als bei Reisstroh. Nach Kalkstickstoffanwendung stieg die CO_2-Entwcklung im Sandboden stärker als im Lehm- bzw. Lössboden. Hohe Aufwandmengen von Kalksticktoff wirkten sich nur bei Reisstroh weiter positiv aus. Nach 70 Tagen hielt die Steigerung der CO_2-Produktion bei Reisstroh weiter an, im Gegensatz zu Weizenstroh. Kalkstickstoff scheint die Zersetzung von Weizenstroh mehr als die von Reisstroh zu fördern und mehr im sandigen als im lehmigen Boden.

Nach Strohzungabe zeigte sich eine deutliche Steigerung der Dehydrogenasenaktivität bei beiden Böden, wobei der Effekt von Weizenstroh bei Sandboden am grössten war. Der Einfluss von Kalkstickstoff war dabei gering.

Die Resultate erlauben folgende Schlussfolgerungen: Der Abbau von beiden Stroharten erfolgt im Sandboden schneller als im Lehmboden. Kalkstickstoff fördert die Zersetzung, wobei im allgemeinen.

Aufwandmengen von 25-50 kg N/ha ausreichend sind. Es ist anzunehmen, dass die positive Wirkung des Kalkstickstoffs alf einer Einschränkung der Bildung unlöslicher organischer N-Verbindungen beruht, die die Folge einer Applikation von organischen Material mit weitem C:N-Verhältnis ist.