

# IMPACT OF LONG -TERM APPLICATION OF CHEMICAL FERTILIZERS, MANURE AND LIME ON THE PH-VALUE OF BROWN LUVIC SOILS IN NORTH-WESTERN ROMANIA

## INFLUENȚA APLICĂRII ÎNDELUNGATE A ÎNGRĂȘĂMINTELOR CHIMICE, A GUNOIULUI DE GRAJD ȘI A AMENDAMENTELOR ASUPRA VALORII PH- ULUI PE SOLULUI BRUN LUVIC DIN NORD-VESTUL ROMÂNIEI

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**Abstract:** In Romania was elaborated since 1968 a stationary long term experiments with fertilizers and lime in all the Agricultural Research Stations belongs to Research Institute from Fundulea. The experiments was set up using a unitary scheme for knowing the evolution of soil fertility and the influence of fertilizers and lime rates and combinations on level and quality yield of different crops. The brown luvisc soil from North-West part of Romania is a medium soil, provide with the principal nutritive elements, with a weak acid reaction in the ploughing horizon. In this paper are presented the results regarding the influence of fertilizers and lime rates and combinations on pH values of brown luvisc soil from North-West part of Romania. Long term fertilization with nitrogen determined the decrease of pH values and the increase of mobile aluminium content up to the phytotoxicity level. Lime application determined the increase of pH values and the decrease of mobile aluminium content obtaining positive effects on yield.

**Rezumat:** În România au fost instalate începând cu anul 1968 experiențe de lungă durată cu îngrășăminte în toate Stațiunile de Cercetare Agricolă, aparținând Institutului Național de Cercetare Agricolă Fundulea. Experiențele au fost inițiate având o schemă unitară în scopul cunoașterii evoluției fertilității solului și a influenței îngrășămintelor și amendamentelor aplicate în diferite doze și combinații asupra producției și calității acestora la diferite plante de cultură. Solul brun luvic din nord-vestul țării este mediu aprovizionat cu principalele elemente nutritive, cu reacție slab acidă în orizontul arabil. În această lucrare se prezintă rezultatele privind influența îngrășămintelor și amendamentelor asupra valorilor pH a solului brun luvic din nord-vestul României. Aplicarea îndelungată a îngrășămintelor cu azot determină descreșterea valorilor pH și creșterea conținutului în Al mobil peste valorile de toxicitate. Aplicarea amendamentelor determină creșterea valorilor pH și descreșterea conținutului în aluminiu mobil obținându-se efecte pozitive asupra producției.

**Key words:** long term experiments, chemical fertilizers, soil reaction

**Cuvinte cheie:** experiențe de lungă durată, fertilizanți chimici, reacția solului

### INTRODUCTION

In Romania acid ploughing soils are spread on 2.0 millions ha which represent 20% from total agricultural land.

The factors which have a negative influence on growing plants are: high level concentration by  $H^+$  and  $Al^{3+}$ , high level soil content in  $Fe^+$  and  $Mn^{2+}$  and low level soil content in principal nutrients elements, low activity of microorganisms, stagnation of water, because of unsatisfactory infiltration.

Much research on white luvic soil and brown luvic soil conditions (Bedo and Lang, 1977, Ciobanu and Nagy 1978, Nemeth 1996, Stefanescu 2003) has shown the negative effect of long-term application of nitrogen as ammonium nitrate on soil reaction, which became more acidic and led to growth of mobile aluminium and manganese soil content, which can determine phytotoxicity in the first part of vegetative period, with negative influence on yield level and quality.

For a better knowledge of application effect on time of chemical fertilizers, manure and lime on soil chemistry was set up in the network of Agricultural Research Stations from Romania, long-term field experiments in different pedoclimatic conditions.

This paper presents the results regarding the influence of NP chemical fertilizers, manure and lime on evolution of brown luvic soil acidity.

## MATERIAL AND METHOD

### Experimental site

The research data was obtained at the Agricultural and Development Research Station Oradea, using a unique design in the all research network of Research Institute from Fundulea.

The investigation has been carried out beginning with the autumn of 1974 in Oradea, in a flat plain area on the third terrace of the Crisul Repede River, whose geographical coordinates are: 21°56' Eastern longitude, 47°03' Northern latitude and 136 m altitude.

The solidification rock consists of clay loam. The ground water is located at a depth of 6-8 m. the soil is a brown one with horizon disposition and the main physical and chemical characteristics are shown in table 1. The presence of clay migration, B horizon is to be remarked noticed on the thickness of the soil profile, with high and very high values of the bulk density and compaction level and low or very low total porosity and hydraulic conductivity.

The soil reaction is acid in the ploughing A horizon, then slightly acid. The lack of CaCO<sub>3</sub> in the soil profile is underlined. The mobile Al content in the A horizon may cause poor growth of some crops (clover). The soil is well provided with mobile potassium and phosphorus. The soil humus medium content may not cause distortions to the neutronic determination of the soil moisture.

Table 1

The main properties of the brown luvic soil from Oradea – Romania

Soil depth cm	Sand	Silt	Clay	OC	Humus %	Ca CO <sub>3</sub> %	Al mobile mg/100g soil	PH 1:2 H <sub>2</sub> O	N Total %	P mobile ppm	Kmobile ppm
0 - 5	43.5	28.3	28.2	1.25	2.32	0.00	3.68	6.3	0.12	21.8	83.0
5 - 15	41.8	28.4	29.8	1.12	2.28	0.00	2.32	6.4	0.11	22.7	102.1
15 - 30	40.0	28.5	31.5	1.02	1.91	0.00	0.52	6.3	0.09	5.7	112.1
30 - 60	32.0	28.0	40.0	0.99	1.93	0.00	0.77	6.6	0.09	6.1	117.9
60 - 90	24.1	36.7	39.2	0.29		0.00	0.32	6.6			
90 - 150	35.1	27.3	37.6	0.17		0.00	0.59	6.5			

The experimental factors in field experiments with NP fertilizers, manure and lime was:

**1. Field experiment with NP was set up in 1974 was used from plants in follow crop rotation-pea-winter wheat-sunflower-maize**

P rates were the same for each plant: 0, 40, 80, 120, 160 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>

N rates were differentiated:

For pea- N<sub>0</sub>, N<sub>25</sub>, N<sub>50</sub>, N<sub>75</sub>, N<sub>100</sub>,

For winter wheat and sunflower- N<sub>0</sub>, N<sub>40</sub>, N<sub>80</sub>, N<sub>120</sub>, N<sub>160</sub>,

For maize- N<sub>0</sub>, N<sub>50</sub>, N<sub>100</sub>, N<sub>150</sub>, N<sub>200</sub>,

The chemical NP fertilizers were: ammonium nitrates and superphosphate

### **2. Field experiment with manure and NP fertilizers was set up in 1974.**

Was used a short plant rotation winter wheat-maize

The manure was applied once at four years in autumn for maize using the rates: 0, 20, 40, and 60 to/ha.

The NP rates were: N<sub>0</sub>P<sub>0</sub>, N<sub>50</sub>P<sub>0</sub>, N<sub>50</sub>P<sub>50</sub> and N<sub>100</sub>P<sub>100</sub>,

### **3. Field experiment with lime was set up in 1974 using a crop rotation: pea, winter wheat, maize, and alfalfa.**

The lime rates were: 0, 3, 6, and 9 to/ha applied once at 6 years.

NPK rates were differentiated:

Pea: N<sub>0</sub>P<sub>80</sub>, N<sub>30</sub>P<sub>80</sub>, N<sub>120</sub>P<sub>80</sub>, N<sub>60</sub>P<sub>80</sub>, N<sub>90</sub>P<sub>80</sub>, N<sub>90</sub>P<sub>80</sub>K<sub>80</sub>,

Winter wheat: N<sub>0</sub>P<sub>80</sub>, N<sub>30</sub>P<sub>80</sub>, N<sub>120</sub>P<sub>80</sub>, N<sub>160</sub>P<sub>80</sub>, N<sub>160</sub>P<sub>80</sub>K<sub>80</sub>,

Maize: N<sub>0</sub>P<sub>80</sub>, N<sub>80</sub>P<sub>80</sub>, N<sub>160</sub>P<sub>80</sub>, N<sub>240</sub>P<sub>80</sub>, N<sub>240</sub>P<sub>80</sub>K<sub>80</sub>,

Alfalfa: N<sub>0</sub>P<sub>100</sub>, N<sub>40</sub>P<sub>100</sub>, N<sub>80</sub>P<sub>100</sub>, N<sub>120</sub>P<sub>100</sub>, N<sub>120</sub>P<sub>100</sub>K<sub>80</sub>,

### **Sampling and analytical method**

Soil samples from top soil (0-20cm) were collected from each experiment plot, in august 2000, after wheat harvesting.

All samples were taken to the laboratory and used for routine soil chemical analysis. pH was determined in water suspension.

## **RESULTS AND DISCUSSION**

### **Influence of NP fertilizers on brown luvic soil reaction (figure 1)**

As an effect of systematically applying of NP fertilizers were registered significant modifications of soil acidity.

The higher influence on soil reaction had the nitrogen fertilizers applied on different P backgrounds.

In the case of background P<sub>0</sub>, applying of N fertilizers lead to decreasing of pH values from 6.20 to 5.15 when N rate is taking values from 0 to 160 kg N/ha.

In the case of all P backgrounds the decreasing trend of pH values due to N fertilizers applied is obvious. Based on the research data was established the interrelations existing between pH values and N rates.

The phosphorus fertilizers applied affected more little pH values but it is noticed a low trend to increase soil acidity once with increasing of P rates, because of depletion of bases as an effect of higher level of yield obtained.

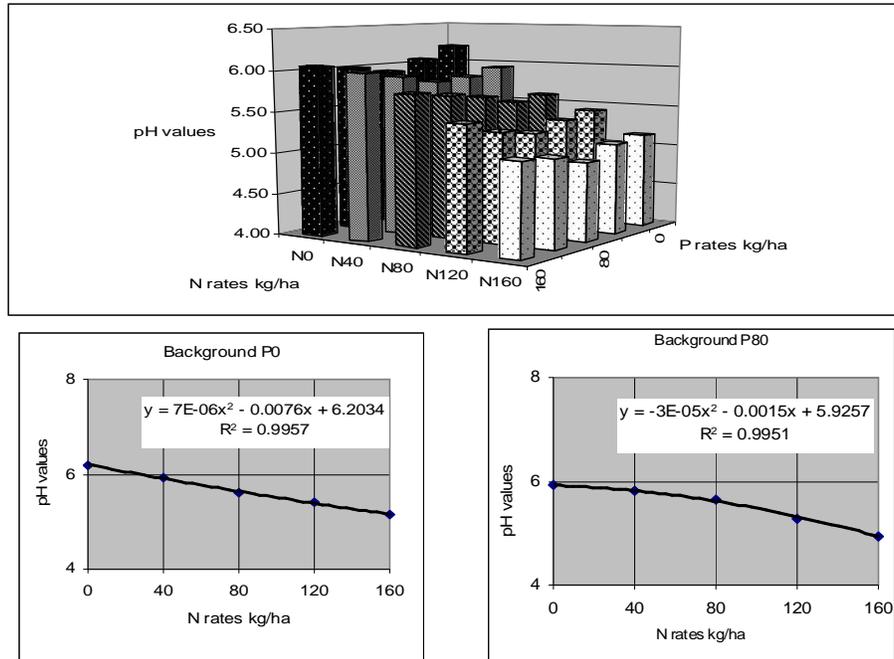


Figure 1 Influence of nitrogen and phosphorus on luvisol soil reaction in north-western Romania

The lower values of pH was registered in the case of plots fertilized with P<sub>80</sub>, when was obtained the higher level of production.

**Influence of manure applied on different NP backgrounds on brown luvisol soil reaction (figure 2)**

It is well known that the manure applied in acid soil conditions is increasing the degree of base saturation in the same time increasing the buffering capacity of the soil. On this way is possible to avoid unfavourable effect of chemical fertilizers with acid potential.

In the brown luvisol soil conditions the manure applied on different NP backgrounds had a significant positive effect on soil acidity. Applying manure in the rates of 20, 40 and 60 to/ha in the lack of N, P fertilizers the pH values are increasing from 6.29 to 6.76 units. In the case of the other NP backgrounds the manure determined an increase of pH values ranging between 0,4-0,6 units. The negative effect of nitrogen fertilizers application is lower in the case of manure application.

Neutralization of soil acidity and completion of calcium reserve (and magnesium) through lime application is an essential measure for increasing yield capacity of acid soils.

In the case of brown luvisol soil application of lime in the rate of 3, 6 and 9 to/ha once at six years lead to increasing of pH values depending on NP background utilized.

When the lime is applied alone pH values are taking values between 6.22 and 7.08 when the lime rates are increasing from 0 to 9 to/ha.

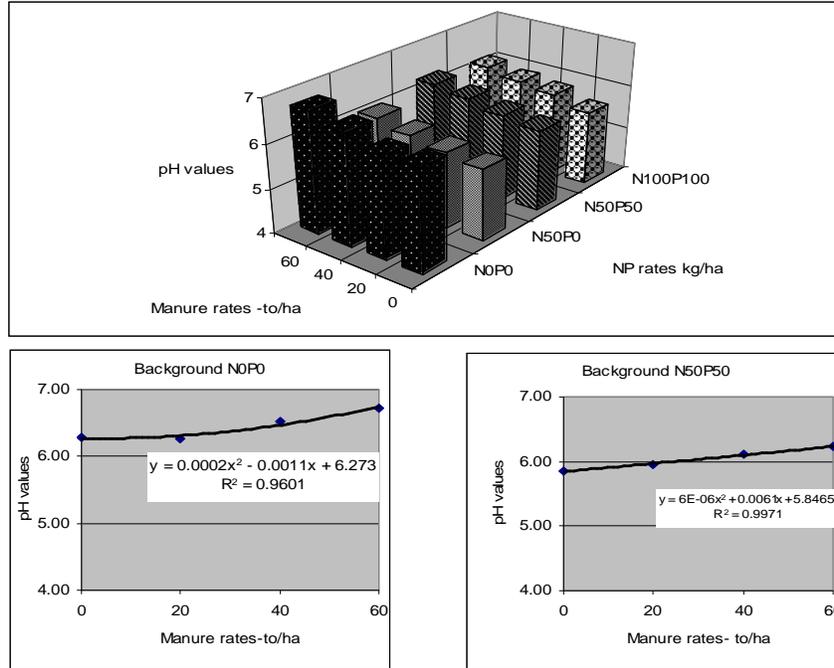
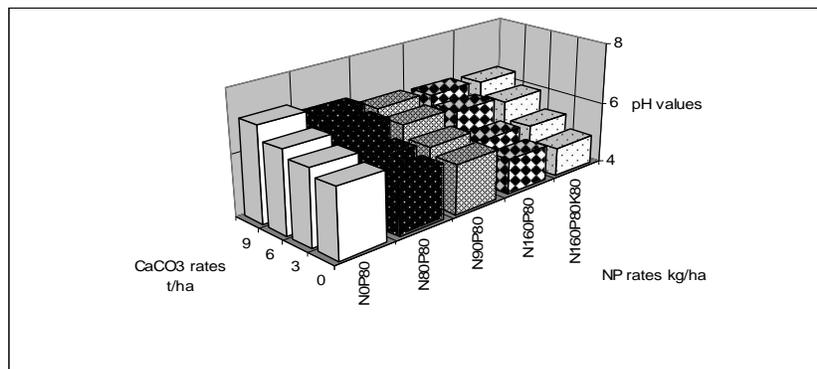


Figure 2 Influence of manure of brown luvic soil reaction from North-West part of Romania

**Influence of lime application on brown luvic soil reaction (figure .3)**

On the other NPK backgrounds the increasing of pH values are taking values between 0,9-1.42 pH units.

Lime application in brown luvic soil conditions is a necessary measure in the case of using NP fertilizers in high rates.



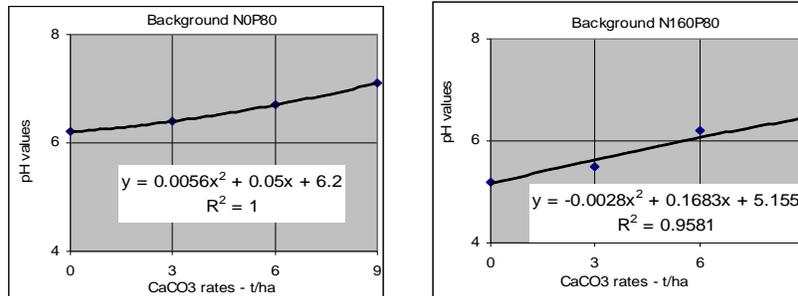


Figure 3 Influence of lime on brown luvisc soil reaction from North-West part of Romania

### CONCLUSIONS

1. Long term experiments are important tools for examining soil fertility
2. The soil reaction evolution is depends by fertilizers type and by the rates level applied
3. In the case of brown luvisc soil from North-West Romania by systematic application of nitrogen fertilizers like as ammonium nitrate leads to a decreasing of pH values from 6.3 to 4.9 as a function of rates level applied
4. Phosphorus fertilizers applied influence not to strong brown luvisc soil reaction but it can be observed a slow decreasing of pH values because of depletion of bases due to yields spores obtained
5. The manure applied alone or associated with NP fertilizers, favourable influenced soil reaction, pH values increasing with 0.3-0.4 units if the manure rates applied are 40 to/ha respectively 60 to/ha
6. For to avoid the decreasing pH values due to chemical fertilizers applied in brown luvisc soil conditions is necessary lime application for acidity neutralization
7. Lime application once at six years in the rate of 9 to/ha maintain pH values between 6.4-7.0, which ensure optimal growing and developing condition for plants

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