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AGROCHEMICAL EVOLUTION OF THE CHERNOZEMIC SOIL IN THE SUPERFICIAL HORIZON BY DIFFERENTIATED NITROGEN FERTILIZATION

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ABSTRACT. Soil fertility, upon which plant growth and hence crop yield and quality depend, embraces its content of plant food (nutrients), its organic matter content, its structure, its ability to supply water and its depth. Excessive use of fertilizers with nitrogen products of ion nitric accumulation in the soil (temporary) and in plants, which disturbs the balance of photosynthesis, causes the appearance of necrosis and burns on leaves, severe intoxication and even death by asphyxiation phenomena and cyanosis at ruminants, children and old people. One of the ways of soil pollution through agricultural technology is over-fertilization and, in particular, the administration of high doses of nitrogen fertilizers. Excess of nitrogen fertilizers, as well as their empirical application, have negative effects on harvest quality. The main aim of this study was to determine the effect of five nitrogen levels and different type of fertilizers on the agrochemical evolution of the chernozemic soil in the superficial horizon. Field experiments were conducted at the Agricultural Research and Development Station (ARDS) Suceava, Romania, in two growing seasons (2017 and 2018) with five nitrogen levels (80 kg/ha, 120 kg/ha, 160 kg/ha, 200 kg/ha and 240 kg/ha) and two type of nitrogen fertilizers (ammonium nitrate and urea).

Keywords: ammonium nitrate; urea; chemical fertilizers; chernozemic soil.

REZUMAT. **Evoluţia agrochimică a solului cernoziomoid în orizontul superficial prin fertilizarea diferenţiată cu azot.** Fertilitatea solului, de care depinde creșterea plantelor și, prin urmare, productivitatea și calitatea culturilor, înglobează conținutul de nutrienți, conținutul de materie organică, structura și capacitatea sa de a furniza apă în adâncime. Una dintre căile de poluare a solului este agricultura intensivă prin folosirea de îngrășăminte chimice, în special administrarea de doze mari de

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îngrășăminte cu azot. Excesul de îngrășăminte cu azot, la fel ca și aplicarea sa empirică, au efecte negative asupra calității recoltelor. Folosirea în exces a îngrășămintelor cu azot nitric produce o acumulare a ionului nitric în sol (temporar) și în plante, ceea ce deregleză echilibrul fotosintezei, determină apariția de necroze și arsuri pe frunze, intoxicații grave și chiar moartea prin fenomene de asfixiere și cenogeneză la animale rumegătoare, copii și bătrâni. Acest studiu a avut ca obiectiv principal efectul diferitelor doze de azot și tipuri de îngrășăminte cu azot asupra evoluției agrochimice a solului cernoziomoid în orizontul superficial. Experiențele au fost realizate la Staţiunea de Cercetare-Dezvoltare Agricolă Suceava, în doi ani consecutivi (2017 şi 2018), cu cinci doze de azot (80 kg/ha; 120 kg/ha; 160 kg/ha; 200 kg/ha și 240 kg/ha) și două tipuri de îngrășăminte (azotat de amoniu și uree).

Cuvinte cheie: azotat de amoniu; uree; îngrășăminte chimice; sol cernoziomoid.

INTRODUCTION

Soil fertility, upon which plant growth and hence crop yield and quality depend, embraces its content of plant food (nutrients), its organic matter content, its structure, its ability to supply water and its depth (Drouineau, 1976; Bibicu, 1997; Cui *et al.,* 2009). It has been said that fertilizers, though they stimulate crop yield, do nothing to bring about improvement in soil fertility. Few authors even said that using fertilizers may cause soil fertility to deteriorate (Tisdale and Nelson, 1975; Scheffer and Schachtschabel, 1979; Kizil *et al.,* 2017). There are no grounds for such opinions; in fact, fertilizers, properly used, are most effective in improving soil fertility, not only as measured by nutrient content, but also in terms of the other components of fertility.

The major nutrients (nitrogen, phosphorus, potassium, calcium, magnesium, sulphur) are taken up in large amounts. Obviously, the higher the soil's content of these nutrients in available form the higher is its fertility. Because nutrients are taken up by the plant as ions, it makes no difference to the growing plant whether these ions originate from the soil itself, from organic manures or from fertilizers (Gutser, 1977; Mengel and Kirkby, 1982; Jipa and Murariu, 2019). When fertilizer is used, *extra* nutrients from outside the agricultural system are added to the soil and, thus, long-term soil fertility is built up (Tinker, 1980; Keller, 1980).

If, as is often the case, the crop does not take up all of the nutrient added as fertilizer, the surplus is mainly retained in the soil so that when fertilizers are used regularly, soil nutrient reserves are built up. Excess nitrogen is easily lost from the soil by leaching and denitrification but N fertilizer does have positive long term beneficial effects on soil fertility (Fruchtenicht *et al.,* 1978).

MATERIALS AND METHODS

For the study agrochemical evolution of the chernozemic soil in the superficial horizon by differentiated nitrogen fertilization it used a factorial combination of two factors: type of fertilizer and N rates. The experiments was placed at the

Suceava Agricultural Research and Development Station (ARDS), Romania, in two growing seasons (2017 and 2018), in randomized complete block design (RCBD) with randomly placed variants. The two nitric fertilizers (ammonium nitrate and urea) were applied after the emergence of the maize plants, using the following variants. V_1 - unfertilized control; V_2 - N_{80}; V_3 - N_{120}; V_4 - N_{160}; V_5 - N_{200}; V_6 - N_{240}.

The main pedo-agrochemical properties of the chernozemic soil from ARDS Suceava are presented in *Table 1*.

Table 1 - Pedo-agrochemical properties of the chernozem soil from ARDS Suceava

Determined indicator		Horizon/Depth (cm)		
		Ap (0-20)	A/B (21-36)	Bt (37-65)
pH H_2O		4.75	4.87	4.98
Humus (%)		3.91	1.98	1.02
N - total (%)		0.186	0.091	0.042
P- mobil (ppm)		5.32	17.9	13
K - mobil (ppm)		117	101	87
Al-mobil 100 g sol		0.35	0.28	0.1
SB me		11.56	12.03	14.38
Sh me		12.36	12.19	11.92
V-SH		48.33	49.67	54.67
CE		110	106.2	113.5
CTSS		37.4	36.1	38.6
NO_3		33.2	10.8	4.6
Part size cycle analysis	Coarse sand (2.0-0.2 mm)	0.61	0.57	0.53
	Fine sand (0.2-0.02 mm)	42.48	40.11	38.76
	Dust I (0.02-0.05 mm)	28.59	30.76	30.67
	Clay (< 0.002 mm)	27.96	28.56	30.04
	Physic clay	41.17	43.29	46,03

Chemical analyses in soil were performed by chemical and physico-chemical methods (Kappen method; Potentiometric method; Kjeldahl method; Flamphotometric method; Colorimetric method, etc. The soil samples were taken in two distinct periods: when the plants had five leaves and at full maturity of maize plants. Soil study site was a degraded chernozem with high clay content (*Table 1*).

RESULTS AND DISCUSSION

From the pedological point of view, the chernozemic soil has a sandy-loamy structure in the Ap and A / B horizons, and in the Bt horizon is loamy-sandy. The sandy-loamy texture denotes an aerated soil with a normal density, favorable for the normal growth and development of maize plants.

The mobile Al content is low, not presenting a toxicity hazard for this type of soil. Below it presented the agrochemical evolution in the soil surface horizon by differentiated fertilization with that two types of nitrogen fertilizers (ammonium nitrate and urea).

Agrochemical evolution in the soil surface horizon by differentiated fertilization with ammonium nitrate

In *Table 2* are presented the agrochemical components of the chernozemic soil from ARDS Suceava, both at the beginning of the vegetation period of maize plants and at the end of the vegetation period, under the conditions of fertilization with ammonium nitrate.

Table 2 - Agrochemical components of the soil, under the conditions of using ammonium nitrate, in two phases of maize plant development

Fertilization levels	pH	humus	Sum of the basic cations	Hydrolytic acidity	Vah* (%)	I.N.**
Five leaves						
unfertilized	4.88	3.86	11.47	8.93	56.23	2.17
80 kg/ha	4.8	3.89	11.57	8.98	56.31	2.19
120 kg/ha	4.74	3.92	12.13	9.87	55.14	2.16
160 kg/ha	4.72	3.77	11.21	9.97	52.93	2
200 kg/ha	4.67	3.57	12.58	10.58	54.3	1.94
240 kg/ha	4.65	3.98	12.97	11.38	53.27	2.12
Full maturity						
unfertilized	4.36	3.17	13.02	15.82	45.15	1.43
80 kg/ha	4.38	3.21	13.21	15.61	45.84	1.47
120 kg/ha	4.35	3.28	12.98	15.72	45.21	1.48
160 kg/ha	4.32	3.47	12.17	16.11	43.04	1.49
200 kg/ha	4.29	3.32	14.11	18.31	43.53	1.44
240 kg/ha	4.3	3.28	13.87	19.55	41.51	1.36

*Vah (%) = percentage saturation in bases; **I.N.: = nitrogen index

Growth parameters including shoot length, root length and seedling total length were also significantly affected by cold stratification ($p< 0.0001$) (From the data presented in the *Table 2*, within the six levels of fertilization, it is observed that pH is acidic, with values between 4.88 - 4.65 in the first phases of vegetation, and between 4.36 - 4.3 at the end of the vegetation period. The evolution of these agrochemical components is presented in *Fig. 1*.

When applying the six levels of fertilization with ammonium nitrate, the main agrochemical components of the soil have undergone some changes (*Fig. 1.*), such as:

- pH, humus content and I.N. had a flat evolution both at the beginning of the maize vegetation and at the end of the vegetation period.
- The sum of the basic exchange cations and the hydrolytic acidity showed slightly higher values at maximum nitrogen doses.
- The hydrolytic acidity at the end of the maize vegetation period, showed higher values than at the beginning of the vegetation period. Vah (%) registered lower values when the increase of fertilization level, the decreasing being more accentuated at the end of the vegetation period.

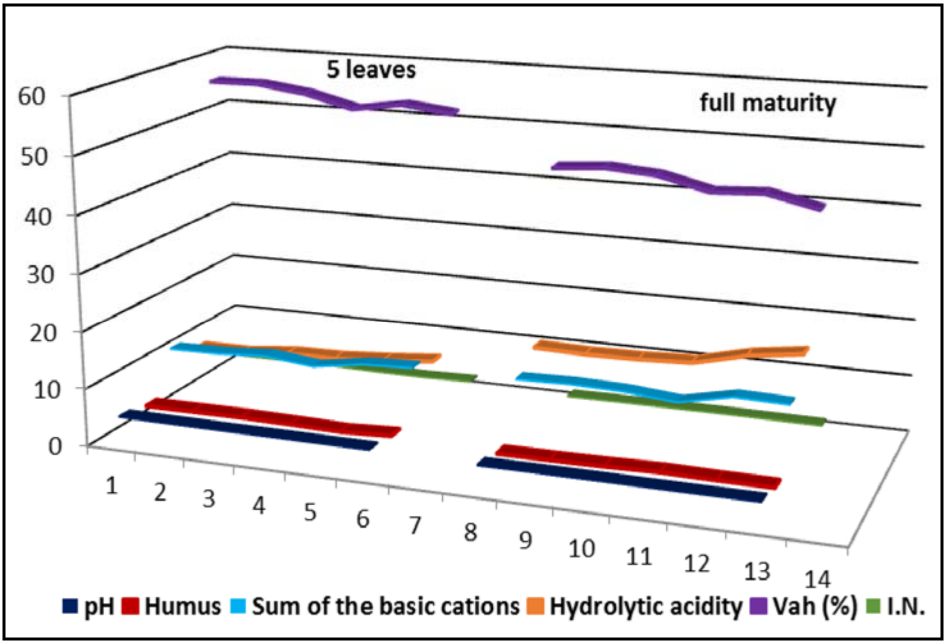

Figure 2 - Evolution of agrochemical components of the soil, within the six levels of fertilization with ammonium nitrate

Table 3 - Agrochemical components of the soil, under the conditions of using urea, in two phases of maize plant development

Fertilization levels	pH	humus	Sum of the basic cations	Hydrolytic acidity	Vah* (%)	I.N.**
			Five leaves			
unfertilized	4.79	3.79	11.53	9.63	54.49	2.06
80 kg/ha	4.82	3.57	11.82	9.32	55.92	2
120 kg/ha	4.84	3.77	12.07	10.11	54.42	2.05
160 kg/ha	4.89	3.98	12.15	9.83	55.28	2.2
200 kg/ha	4.93	4.11	12.31	9.77	55.76	2.29
240 kg/ha	4.95	3.87	12.42	9.68	56.2	2.18
			Full maturity			
unertilized	4.35	3.12	12.17	14.77	45.18	1.41
80 kg/ha	4.3	3.27	12.58	15.09	45.47	1.48
120 kg/ha	4.24	3.47	12.63	16.55	43.29	1.5
160 kg/ha	4.18	3.23	14.72	17.92	45.1	1.46
200 kg/ha	4.2	3.67	14.02	18.08	46.68	1.6
240 kg/ha	4.21	3.58	13.87	17.88	43.69	1.57

*Vah (%) = percentage saturation in bases; **I.N.: = nitrogen index

Agrochemical evolution in the soil surface horizon by differentiated fertilization with urea

In *Table 3* are presented the agrochemical components of the chernozemic soil from ARDS Suceava, under the conditions of urea fertilization, both at the beginning of the vegetation period of maize plants and at the end of their vegetation period.

From the data presented in the *Table 2*, within the six levels of fertilization, it is observed that pH is acidic, with values between 4.79 - 4.95 in the first phases of vegetation, and between 4.35 - 4.21 at the end of the vegetation period. The evolution of these agrochemical components is presented in *Fig. 2*.

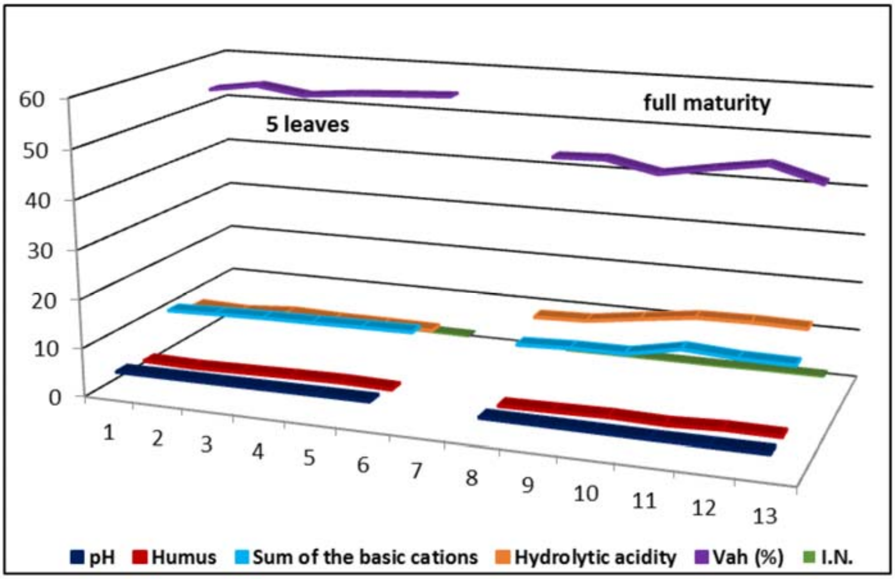

Figure 2 - Evolution of agrochemical components of the soil, within the six levels of fertilization with urea

When applying the six levels of fertilization with urea, the main agrochemical components of the soil have undergone some changes (*Fig. 1*), such as (*Fig. 2*):

- As in the case of ammonium nitrate, pH, humus content and I.N. had a flat evolution both at the beginning of the maize vegetation and at the end of the vegetation period.
- The sum of the basic exchange cations and the hydrolytic acidity showed a flat evolution at the beginning of maize vegetation period, but they increased slightly at the end of the vegetation period, when it was used of doses over 160 kg/ha.

Vah (%) recorded slightly higher values, when applying doses over 160 kg/ha, and lower at the end of the vegetation period, with the increase of fertilizer doses.

CONCLUSION

It was concluded from this study, the levels and type of fertilizer have different influence on agrochemical components of the chernozemic soil from the ARDS Suceava.

Regarding to pH, humus content and I.N. it is noticed a same agrochemical evolution at both type of fertilizers.

Concerning the sum of the basic exchange cations and the hydrolytic acidity showed slightly higher values at maximum nitrogen doses, when it used ammonium nitrate.

Referring to agrochemical evolution in the soil surface horizon by differentiated fertilization with urea, it is observed, that the sum of the basic exchange cations and the hydrolytic acidity showed a flat evolution at the beginning of maize vegetation period, but they increased slightly at the end of the vegetation period, when it was used of doses over 160 kg/ha.

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