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ORIGINAL RESEARCH PAPER

INFLUENCE OF SOIL FERTILIZATION SYSTEMS ON SOIL CHARACTERISTICS FOR A MONOCULTURE OF SUNFLOWER

Oana-Maria Muscalu (Plescan)[1,2], Florin-Marian Nedeff[1*], Elena Partal[3], Emilian Mosnegutu[1], Mirela Panainte-Lehadus[1], Oana Irimia[1], Claudia Tomozei[1]

[1] "Vasile Alecsandri" University of Bacau, Faculty of Engineering, 157 Calea Marasesti, 600115, Bacau, Romania
[2]Romanian Waters - National Administration of Siret Basin, 1 Cuza Voda St., 600274, Bacau, Romania
[3]National Agricultural Research and Development Institute of Fundulea, Calarasi, 1 Nicolae Titulescu Str., 915200, Fundulea, Romania

*Corresponding author: florin_nedeff@ub.ro

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Abstract: The purpose of this research has been to determine the influence of soil fertilizations systems (fertilization with: nitrogen, phosphorus, nitrogen and phosphorus, farmyard manure) on some soil characteristics humidity, *p*H and content in: lead, cadmium, calcium, iron). The experiments have been carried out in the experimental field of National Agricultural Research and Development Institute – Fundulea, Romania, for a sunflower monoculture. The lowest values of the metal content in soil (lead) have been recorded for sunflower experimental variants – fertilized with farmyard manure (2.18 $mg \cdot kg^{-1}$ d.m.). Calcium has the highest content in soil (4712 $mg \cdot kg^{-1}$ d.m., 15-30 cm working depth) in case of the soil control sample.

Keywords: *cadmium, calcium, farmyard manure, fertilizations systems, humidity, iron, lead, pH, sunflower*

INTRODUCTION

The importance of sunflower culture is given by its wide use in human nutrition, but also in animal feed, including industrial and energy uses [1 – 12].
Sunflower is a sensitive plant to soil conditions - prefers medium textured soils, aerated, without natural or technological settling, well drained, with good exposure, weak acid-neutral (*p*H = 6.5-7.2), well supplied in the essential fertilizing elements being appreciated from this point of view as a crop plant with high demand for soil fertility level [3, 8, 12 – 28].
Fertilization process plays an essential role in obtaining a high quality sunflower production. With high productive potential, sunflower consumes large amounts of nutrients [3, 4, 8, 12, 29 – 40].
On all soil types, sunflower makes good use of both organic and chemical fertilizers [12, 17, 22, 25]. The manure is well used, especially on the heavy and cold soils, but it is also recommended on lighter soils, in doses of 20 t/ha that are immediately incorporated by the basic plow [1 – 4, 17, 41 – 45].
The doses of chemical fertilizers are established taking into account, mainly from the level of the expected production, the specific consumption and the reserves of the soil in nutrients, but other factors such as: pre-emergent plant, fertilization applied in previous years, degree of soil water supply, used cultivar, micro and macro organisms etc. [1 – 4, 46].
Establishing an efficient system of fertilization in the sunflower implies the application of fertilizers according to the biological particularities of the plant and the chemical and hydrophysical properties of the soil [3, 4, 12, 40, 47 – 51].
The purpose of this research has been to determine the influence of soil fertilizations systems on the characteristic of soil (content in: lead, cadmium, calcium, iron, humidity and *p*H) for a monoculture of sunflower.

MATERIALS AND METHODS

When choosing the sampling point in order to determine the properties of the soil, the research team considered the topo-pedological base of the agrochemical cropping plots, updated with all necessary elements to identify and locate the plots [3, 4, 12].
The study has been carried out in the experimental field of National Agricultural Research and Development Institute – Fundulea, Romania, for a sunflower monoculture. The researches at INCDA have been carried out a two-factor experience, stationary and multiannual, mounted in 1968 and up to date, in order to emphasize the differentiation of soil's properties as an effect of fertilization sequence [3, 4, 12], i.e.:
- nitrogen (90 kg N/ha active matter – active matter);
- phosphorus (75 kg P/ha active matter);
- nitrogen and phosphorus (N90P75 kg/ha active matter);
- farmyard manure.

The experimental variants carried out at INCDA have been of the following type [3, 4, 12]:
- sunflower monoculture (Factor a): a_1.
- fertilization with (Factor b):

- unfertilized: b_1 (N0P0 kg/ha active matter);
- nitrogen - 90 kg N/ha active matter: b_2;
- phosphorus - 75 kg P/ha active matter: b_3;
- nitrogen and phosphorus - N90P75 kg/ha active matter: b_4;
- farmyard manure: b_5.

The soil samples have been taken on two depths [3, 4, 12]:
- 0 - 15 cm;
- 15 - 30 cm.

The soil samples have been taken in 2017. All soil samples have been collected as a composite form each parcel after sunflower harvesting.
Experiments have been carried out for the content of lead, cadmium, calcium, iron, humidity, *p*H in the soil.
The metal content in the soil samples has been determined by using atomic absorption spectrometer (AAS, Figure 1), ZEENIT AAS version [52].

Figure 1. *Atomic absorption spectrometer (AAS), Zeenit 700 version [52]*

InoLab 740 multiparameter (Figure 2) was used to determine the *p*H of soil [53].

Figure 2. *InoLab 740 multiparameter [53]*

RESULTS AND DISCUSSION

Table 1 shows the experimentally determined values for the soil samples taken on the unfertilized sunflower parcel (control sample), for lead, cadmium, calcium, iron, humidity and *p*H.

Table 1. *Experimentally determined values for lead, cadmium, calcium, iron, humidity and pH, in the unfertilized soil parcel (control sample)*

Depth [cm]	Pb	Cd	Ca	Fe	Humidity	*p*H
	[mg·kg^{-1} d.m.]				[%]	[unit. *p*H]
0-15	12.13	0.14	3009.0	345.8	30	7.19
15-30	12.79	0.13	4712.0	323.5	18	7.25

The lead content value (Figure 3) registered in the parcel with nitrogen fertilization (90 kg N/ha) was 17.55 % lower than the value registered in the unfertilized soil parcel for the 0-15 cm depth, respectively by 13.83 % lower than the control sample for the 15-30 cm depth.

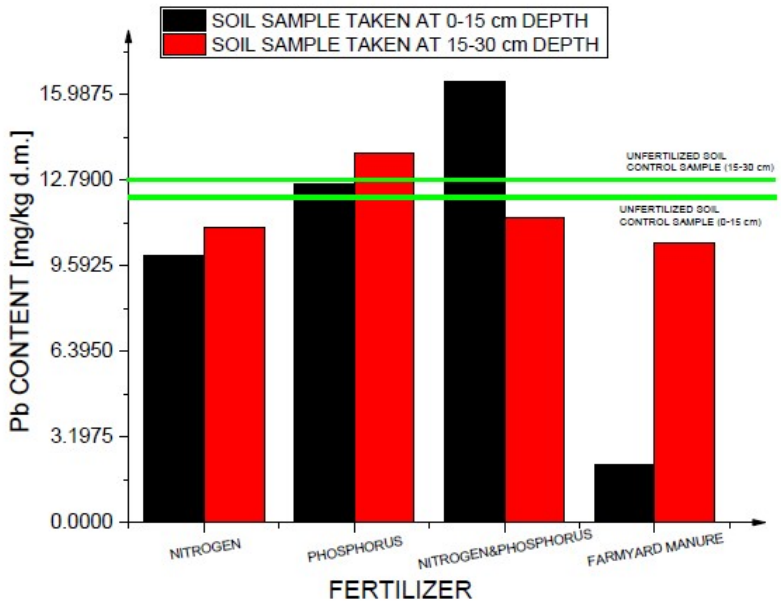

Figure 3. *Lead content in soil parcels fertilized with nitrogen, phosphorus, nitrogen and phosphorus, farmyard manure, for the 0-15 cm and 15-30 cm depths*

In the case of the phosphorus fertilized parcel (75 kg P/ha) the soil lead content was:
- 104.36 % higher than the value registered on the unfertilized soil parcel for the 0-15 cm depth;
- 107.97 % higher for the 15-30 cm depth, than the control sample.

The lead content for the experimental sunflower variants – fertilized with nitrogen and phosphorus N90P75 kg/ha (a_1b_4) and sunflower – fertilized with farmyard manure (a_1b_5) was:
- sunflower – fertilization with nitrogen and phosphorus N90P75 kg/ha (a_1b_4):
  - 0-15 cm: 137.77 % higher the valued registered in the soil control sample value;
  - 15-30 cm: 89.21 % of valued registered in the soil control sample value;
- sunflower – fertilization with farmyard manure (a_1b_5):
  - 0-15 cm: 17.97 % of valued registered in the soil sample without a fertilization sequence;
  - 15-30 cm: 81.7 % of valued registered in the soil sample without a fertilization sequence.

The cadmium content value (Figure 4) in the parcel with nitrogen fertilization was 7.14 % lower than the control sample value for the 0-15 cm depth. For the 15-30 cm depth the cadmium content was 115.38 % higher than the value registered in the control sample value.

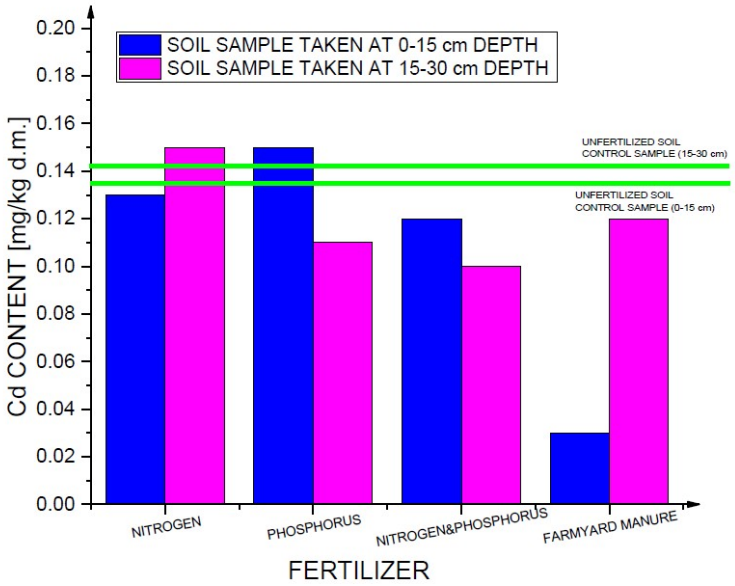

Figure 4. *Cadmium content on soil parcels fertilized with nitrogen, phosphorus, nitrogen and phosphorus, farmyard manure for the 0-15 cm and 15-30 cm depths*

For the soil parcel fertilized with 75 kg P/ha (b_3) factor, the cadmium content was 107.14 % higher than the control sample value, for the 0-15 cm depth, respectively 15.38 % lower than the control sample value for the 15-30 cm depth.
The cadmium content for the experimental sunflower variants – fertilized with nitrogen and phosphorus N90P75 kg/ha (a_1b_4) was:
- 0-15 cm: 85.71 % of the soil control sample value;
- 15-30 cm: 76.92 % of the soil control sample value;

The cadmium content for the experimental sunflower variants – fertilized with farmyard manure (b_5) was:
- 0-15 cm: 21.42 % of the soil control sample value;
- 15-30 cm: 7.69 % lower than the valued registered in the soil control sample value.

The calcium content value (Figure 5) registered for the soil parcel fertilized with nitrogen was 29.37 % lower than the value registered for the unfertilized soil parcel for the 0-15 cm depth, respectively 44.18 % lower than the control sample, for the 15-30 cm depth.
In the case of the phosphorus fertilized parcel (75 kg P/ha), the soil calcium content was:
- 9.06 % lower than the value registered on the unfertilized soil parcel for the 0-15 cm depth;
- 63.39 % lower for the 15-30 cm depth than the control sample.

The calcium content for the experimental sunflower variant – fertilized with nitrogen and phosphorus N90P75 kg/ha (a_1b_4) was:
- 0-15 cm: 28.48 % of the valued registered in the soil control sample value;
- 15-30 cm: 40.95% of the soil control sample value.

For the soil parcel fertilized with farmyard manure (b_5) the calcium content was 141.24 % higher than the control sample value, for the 0-15 cm depth, respectively 32.53 % lower than the control sample, for the 15-30 cm depth.

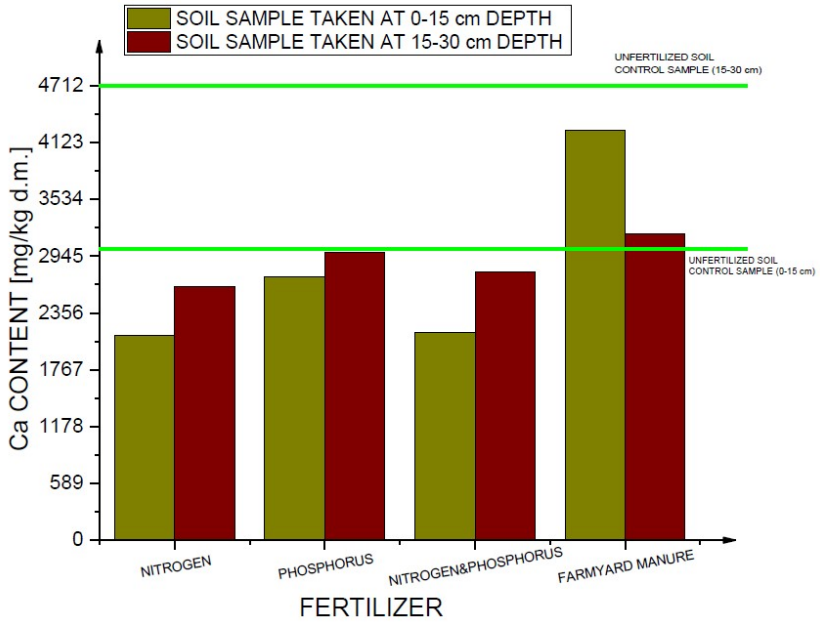

Figure 5. *Calcium content on soil parcels fertilized with nitrogen, phosphorus, nitrogen and phosphorus, farmyard manure for the 0-15 cm and 15-30 cm depths*

Iron content (Figure 6) for the analyzed experimental variants was:
- sunflower – fertilization with nitrogen - 90 kg N/ha (a_1b_2):
  - 0-15 cm: 38.11 % lower than the valued registered in the soil sample without a fertilization sequence;
  - 15-30 cm: 78.08 % of the soil control sample value.
- sunflower – fertilization with phosphorus -75 kg P/ha (a_1b_3):
  - 0-15 cm: cu 35.82 % lower than the valued registered in the soil sample without a fertilization sequence;
  - 15-30 cm: cu 84.29 % of the soil control sample value.
- sunflower – fertilization with nitrogen and phosphorus - N90P75 kg/ha (a_1b_4):
  - 0-15 cm: 56.41 % of the soil control sample value;
  - 15-30 cm: 65.40 % of the soil control sample value;
- sunflower– fertilization with farmyard manure (a_1b_5):
  - 0-15 cm: cu 13.33 % lower than the valued registered in the soil sample without a fertilization sequence;
  - 15-30 cm: cu 13.26 % lower than the valued registered in the soil sample without a fertilization sequence.

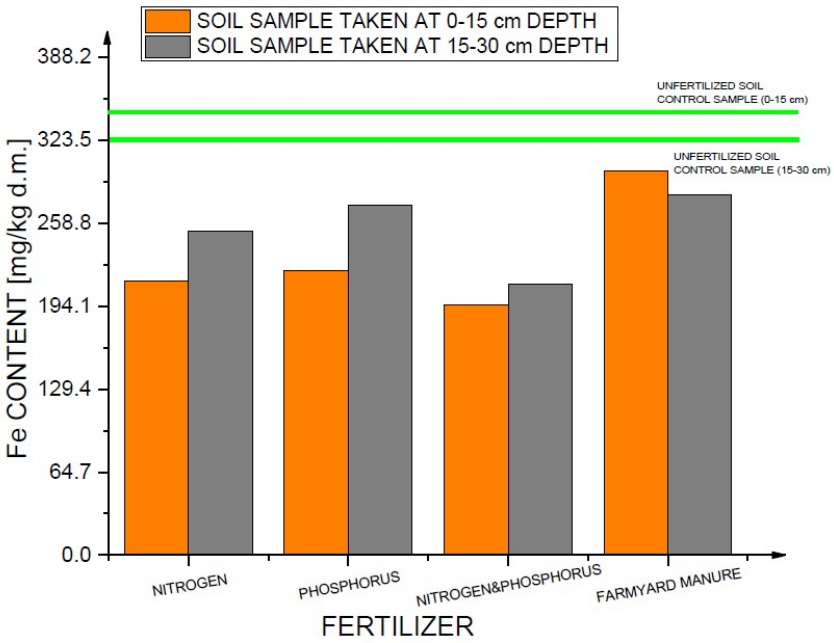

Figure 6. *Iron content on soil parcels fertilized with nitrogen, phosphorus, nitrogen and phosphorus, farmyard manure for the 0-15 cm and 15-30 cm depths*

Table 2 shows the experimentally determined values of soil humidity and *p*H for the analyzed experimental variants.

Table 2. *Experimentally determined values for humidity and pH for soil parcels where a fertilization sequence has been applied*

Experimental value	Depth [cm]	Humidity [%]	*p*H [unit. *p*H]
a_1b_2	0-15	25	6.64
	15-30	12	6.87
a_1b_3	0-15	20	6.86
	15-30	18	6.74
a_1b_4	0-15	26	6.03
	15-30	17	6.06
a_1b_5	0-15	25	6.75
	15-30	17	6.99

Soil humidity has been registered with values between 12 and 30 %. Soil humidity value for the soil parcel where a fertilization sequence has been applied (sunflower - fertilization with nitrogen -90 kg N/ha -a_1b_2) was 16.66 % lower than the value registered on unfertilized soil parcel for the 0-15 cm depth.
For the 15-30 cm working depth (sunflower – fertilization with nitrogen – 90 kg N/ha - a_1b_2), the soil humidity lowered by 33.33 % compared to the soil control sample.
For the experimental sunflower variants – fertilization with phosphorus -75 kg P/ha (a_1b_3) soil humidity for the 10-15 cm working depth was 66.66 % of the soil control sample, and for the 15-30 cm depth it has the same value of the soil control sample (18 %).

Humidity content for the analyzed experimental variants was:
- sunflower – fertilization with nitrogen and phosphorus - N90P75 kg/ha (a_1b_4):
  - 0-15 cm: 86.66 % of the soil control sample value;
  - 15-30 cm: 94.44 % of the soil control sample value;
- sunflower – fertilization with farmyard manure (a_1b_5):
  - 0-15 cm: cu 16.66 % lower than the valued registered in the soil sample without a fertilization sequence;
  - 15-30 cm: cu 5.55 % lower than the valued registered in the soil sample without a fertilization sequence.

The analysis of soil samples also showed that the fertilization induce a *p*H diminution compared to values registered in soil control samples – sunflower monoculture (values between 6.03 for the sunflower monoculture fertilized with nitrogen and phosphorus N90P75 kg/ha – a_1b_4 - 0-15 cm work depth, and 7.25 for the a_1b_1, unfertilized sunflower monoculture variant - 15-30 cm work depth).
The lowest *p*H values have been registered for the a_1b_4 experimental value – sunflower monoculture fertilized with nitrogen and phosphorus N90P75 kg/ha, for the both work depths.

CONCLUSIONS

The research carried out in 2017 with regard to the influence of fertilizations systems (fertilization with: nitrogen, phosphorus, nitrogen and phosphorus, farmyard manure) on the characteristics (humidity, *p*H and metal content - lead, cadmium, calcium, iron) of the soil for a monoculture of sunflower emphasized the following aspects:
- the lead content for the experimental sunflower variants - fertilized with farmyard manure (a_1b_5) was the lower value registered for the level 0-15 cm – 17.97 % of the soil control sample value;
- the cadmium content for the experimental sunflower variants – fertilized with azote nitrogen -90 kg N/ha (a_1b_2) the soil cadmium content was the higher value registered for the level 0-15 cm: 115.38 % higher than the value registered on the unfertilized soil parcel;
- in case of calcium for the experimental sunflower variants – fertilized with farmyard manure (a_1b_5) was the higher value registered for the level 0-15 cm (141.24 % higher than the value registered of the soil control sample value);
- in case of iron, the values registered in the soil, were under soil control sample value, for all the fertilizations systems applied (211.6 $mg \cdot kg^{-1}$ d.m. ÷ 299.7 $mg \cdot kg^{-1}$ d.m.);
- the higher value of humidity was registered in case of soil control sample (30 %) for the working depth 0-15 cm;
- the lowest value of *p*H was registered for the experimental sunflower variants – fertilization with phosphorus -75 kg P/ha (6.03 ÷ 6.06 unit. *p*H).

The variation of lead, cadmium, calcium and iron content in soil is due to the absorption capacity of the plant species *Helianthus annuus* (sunflower), through the continuous phyto-extraction and induced phyto-extraction processes.

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