RESEARCH ON THE AGROCHEMICAL POTENTIAL OF LAND WITHIN THE EZARENI FARM, IASI COUNTY

Cosmin Costel MOLOCEA[1], Sorin CĂPȘUNĂ[1], Serginho Segla CAKPO[1], Denis ȚOPA[1], Gerard JITĂREANU[1]

e-mail: moloceacosmin@yahoo.com

Abstract

Soil fertility represents the ability to provide plants throughout the vegetation period, permanently and simultaneously with nutrients and water, in quantities satisfactory to their needs. The assessment of the nitrogen supply status of plants is influenced by the organic matter content in the soil that stores more than 80% of the total nitrogen reserve in the analyzed layer. Under the action of microorganisms in the soil, the mineralization of organic matter takes place, with the release in the form of ammonia (the ammonia process) then it is oxidized and converted into nitrates (the nitrification process) both forms accessible to plants, easily leaching also, especially the second form that is not fixed in any mineral or organic compounds in the soil. The topographic plot *127a* analyzed in the study belongs to Research Station of Ezareni, part of the Iasi University of Life Sciences, occupying an area of 12,90 ha, in which the sunflower crop was sown. Two agrochemical samples were taken after the sunflower crop was harvested. The land is located on the southern part of the farm, on a plateau with an overall slope of less than 5 % and oscillates in the eastern part between 5-7 %, with a minimum altitude of 92 m in the eastern part, and in the western part the maximum of 122 m, with an eastern exposure. After sampling of agrochemical samples, the removal of plant residues and their grinding followed, and subsequently introduced into the analytical flow of the chemistry laboratory where the following determinations were carried out: pH, humus content, nitrogen index, P-ppm, K-ppm, Fe-ppm, Mn-ppm, Cu-ppm.

Key words: fertility, humus, pH

The 1990 drought in North Africa and the Dust Bowl between 1930 and 1936 in America are sad reminders that we need to prepare better for future soil crises. Today, the world faces great challenges in terms of resource degradation, including the degradation of soil, water, and air and not least, natural vegetation. Considering that soil is under threat globally, we owe to invest in practices that improve soil quality and agricultural practices. High expectations are placed on soil science and research to respond successfully to these challenges.

Soil organic matter, its stable components (humic substances) and its transient components can strongly improve nutrient availability and acquisition by higher plants. Soil organic matter also strongly affects nutrient storage and its availability in soils. For nitrogen (N) and sulfur (S), and in many soils for P, soil organic matter is the main pool of nutrient storage. In the case of micronutrients, especially iron (Fe) and copper (Cu), and to some extent zinc (Zn), soil organic matter determines the availability of these micronutrients to plants (Gerke J., 2022).

High yields in agriculture require adequate to high supplies of plant mineral nutrients both macronutrients and micronutrients. Soil organic carbon plays, therefore, a central role in nutrient soil availability, strongly affecting N and probably S delivery to the plant roots and strongly affecting P, Fe and Cu availability.

The use of chemical fertilisers, especially nitrogen and phosphorus fertilisers, has been and is a general practice globally to increase agricultural production to feed a growing population. The increase of nitrogen to 102 kg N/ha worldwide has favored negative processes in the air, soil, groundwater (Mulvaney *et al,* 2009), from that reason the European Union has issued binding directives to member countries aimed at reducing the negative effects of nitrogen pollution.

From FAO studies on the correlation between fertiliser consumption and agricultural production per hectare shows that: the production value index increases with the amount of fertiliser used. Agricultural production expressed in value terms is high for countries such as Japan, the Netherlands, Belgium with consumption above

[1] Iasi University of Life Sciences, Romania

400-500 kg active substance per hectare, while in countries such as Thailand, India, Syria, Indonesia with low consumption of fertilizer per hectare, they also have low value index of production. Analyzing the worldwide consumption of mineral fertilisers (active substance) applied in different regions of the world, about 50% of all mineral fertilisers are used in cereal crops (rice, maize, wheat) and 50% of the total is consumed by USA, China, India.

Globally, fertiliser consumption is estimated to have increased from 106,18 million metric tonnes in 2015 to 107,55 million metric tonens and 199 million metric tonnes in 2030 (FAO, 2022).

Most of the world's fertiliser supply will be used in East Asia and South Asia, which together represent almost half of the world demand. To increase productivity on soils with additional investment in fertilizer will be necessary. Main objectives aim to develop and adopt productive, sustainable and less polluting systems.

In Romania, between 1928 and 1933, the average fertiliser consumption per hectare, in relation to area of Romania, was 0.217 kg gross manure and in 1938 0.820 kg gross manure.

After 1955, the production of chemical fertilizers developed greatly, so that in average per hectare of arable land in 1989/1990 more than 120 kg of fertiliser was used per hectare active substance (N + P_2O_5 + K_2O), which amounts to about 200-230 kg/ha raw fertiliser.

After 1990, fertiliser production and consumption in our country declined due to the transition period and economic difficulties, with fertiliser consumption falling dramatically, on average per arable hectare, to 48 kg N, P, K in 1994, 47 kg N, P, K in 1995, 43 kg N, P, K in 1996, 40 kg N, P, K in 1997, 38 kg N, P, K in 1998 and 33 kg N, P, K in 1999. In 2007, the average per arable hectare was 38.7 kg N, P, K, in which year the total production of chemical fertilizers (N, P, K) amounted to 387 thousand tonnes, of which 379 thousand tonnes were used in the mainly private farming system (Roxana Madjar, 2009).

Precision farming means exploiting all technological levers to increase yields, profits and reduce the negative impact that fertilizers and pesticides can have on the environment (Sparovek, G., Schunk, F., 2001).

In terms of crop establishment and maintenance program, about 40% of the expenditure is directed to the procurement of fertilizers (Berca M, 2008). If these are not managed correctly, we cannot achieve the desired result, we have very high expenses and the profit is very low (Hera C.R., Borlan Z., 1980).

Fertilisation recommendations are based on soil chemical analysis (soil maps agrochemicals), but also the specific nutrient consumption for each type of crop, taking into account desired yield level (Bergman, W., 1992). Soil analysis helps farmers to know the trophicity of the soil, the degree of nutrient supply, for each crop. These analyses are the way to identify possible deficiencies in order to correct them and are the starting point for establishing balanced fertilisation programmes.

In soil fertility assessment systems, soil analysis determines the soil response (pH), humus content, macro and microelements and other indicators that allow to define efficient fertilisation systems in order to achieve high and sustainable agricultural yields quality (Borlan, Z. *et al*, 1992).

Globally, major climate and pedological changes are important and limiting factors for crop yields, but by implementing new technologies in the agricultural sector and taking into account the correct management of fertilizers where and how much is needed, we can count on maximum results. Modern cultivation and crop maintenance technologies will be taken up on farms and nutrient application schemes will be implemented to contribute directly to the normal course of metabolism and to the growth of vegetative mass (Lixandru, Gh., 2006).

More than 60 elements that make up plants play a complex role, participating alone or together with others, in the form of anionic or acidic groups (C, N, S, P), basic cations cations (K, Ca, Mg), cations of variable valency (Mn, Fe, Cu, Zn) in numerous processes synthesis, transport, deposition of substances, activation or catalysis of other processes, exchange and energy transfer (Lixandru A. *et al*, 1990).

Carbon, hydrogen, oxygen have a share in the plant composition of approximately 90%; nitrogen, phosphorus, sulphur, potassium represent about 4.4% and calcium, magnesium, sodium, silicon, chlorine account for 2.7% (Davidescu V., Davidescu D., 1999). The nutrient content of plants is an indicator of their requirements for with a direct influence on the quality of the plants and thus on the yields obtained (Lăcătușu R., 2000). Agrochemicals improve crop productivity via protecting crops from insects, weeds, and other pathogens that impact crop yield and, at the same time, replenish soils deficient in plant nutrients. The conclusions on the nexus between agrochemical use and crop productivity among existing studies indicate that agrochemical use has conditional effects on crop yield. Since agrochemicals increase crop productivity, applying agrochemicals is stimulated by economics, though they also come with significant environmental costs that are always internalized. For this reason, knowing the determinants and optimal levels of agrochemical usage is important. Additionally, focusing on the distribution of the impact and the average treatment effects could provide a more precise depiction of how adoption of agrochemicals affects productivity (Kwabena N.A. *et al*, 2022).

Period of application, efficacy and dose of fertilizer have been the subject of much research at NARDI Fundulea. Fractional autumn and spring fertilization achieved a growth factor for use of fertilizers by 8-9% (Burlacu *et al*, 2007). Also, in a three-year study with 4 different tillage treatments and 3 nitrogen fertilization levels for winter wheat, Stošić et al (2017) mentioned that, excluding the weather conditions, the strongest influence on the investigated parameters had tillage treatments, and much less Nitrogen fertiliser and at the end tillage treatment × Nitrogen fertilise interaction. In Romania, the optimum N fertilization rate of wheat is locally regarded as 120 Kg N ha-1 or 80 kg N ha-1 when is cultivated after pea. Also, yield benefits are greater when N is applied at tillering than when it is applied at planting; higher values of N fertilizer recovery can be obtained after application at tillering. N fertilizer use efficiency ranging from 25-35%, the highest value being obtained with N applied at 54 kg ha-1 at tillering after pea crop.

Nitrogen is the main factor in growth and development of plants, with positive influence on rooting, tillering, leaf system development and photosynthesis process, the elements of productivity and also quality (Matei G., 2014).

Nitrogen plays a major role in increasing plant production and its deficiency is believed to be the most frequent factor restricting plant growth (Zotarelli *et al*, 2008). According to many authors (Kruczek, Szulc, 2000; Małecka, Blecharczyk, 2005; Ciepiela *et al*, 2012), effectiveness of nitrogen fertilization is displayed in the quantitative and qualitative yield characteristics, as well as physiological effectiveness (plant's ability to convert nitrogen supplied with fertilizers to usable yield) and agricultural effectiveness (yield increase per unit of N applied with fertilizers).

MATERIAL AND METHOD

The experiment was conducted at the Didactic Station of the University Life Sciences of Iasi (IULS), Ezareni Farm. The experiment was located in the southern part of the farm, on a cambic chernozem, with a clay-loam texture, the pH oscillates between 5.8 and 6.8 depending on the slope of the land, the humus content is 3.5%, and the nitrogen index has a value of 3.4. On sloping lands, the change in the chemical reaction of the soil is more pronounced and faster, due to the lower content of organic matter and nutrients in these soils. The pH has a value of 5.8 where the land has a slope more than 7% being considered an acidic soil. The pH increases to 6.8 on a slope of 3-5%, entering the class of slightly acidic soils. To collect agrochemical samples, it was necessary to establish a material base and establish certain sampling criteria, depending on the nature of land use, the variability of the soil and fertilization.

The topo-pedological base is used to establish the plots for the samples of the average agrochemical samples. Their size depends on the pedological complexity, the way of use and the fertilization history. The agrochemical samples were taken from the topographic plot 127a, which has an area of 12.90 ha, cultivated with the sunflower crop. Immediately after harvesting the sunflower crop, four agrochemical samples were taken recorded as 1004, 1005, 1006 and 1007. The sampling was carried out using the Honda - Wintex 1000 ATV, which is equipped with a metal probe with a collecting channel having a length of 0-30 cm. After taking the samples, the soil was dried at room temperature. After drying, plant debris and other materials are removed.

The soil is crushed and sieved, and the fractions smaller than 2 mm are separated by mechanical means or by hand, into portions that allow representative subsampling for analysis. If the analyzes require smaller sampling, it is necessary to reduce the particle size in the fraction smaller than 2 mm.

The pH was determined by the potentiometric method, in soil suspensions (aqueous or saline) with different ratios of soil: liquid phase (mass: volume). The determination of accessible phosphorus and potassium is carried out with an ammonium acetate solution (according to Egner-Riehm-Domingo) (*table 1*).

Table 1

Soil reaction characterization limits

(ICPA București, 1981)

pH	Soil reaction status
< 5.0	strongly acid
5.01 – 5.80	moderately acid
5.81 – 6.80	slightly acid
6.81 – 7.20	neutral
7.21 – 8.40	slightly alkaline
> 8.40	strongly alkaline

Phosphates and potassium are extracted from the soil sample with an ammonium lactate acetate solution at pH = 3.75. due to the acidic pH and the complexation capacity for Ca^{2+}, Al^{3+} Fe^{3+} cations, the solution extracts K and P corresponding to the Q factor and reduced amounts of mineral phosphates from the soil by which it solubilizes them through the dissolution and complexation effect. The hydrogen and ammonium ions of the extraction solution replace by exchange, being in excess, the potassium ions in the exchangeable form of the soil sample which are thus passed into the solution. Potassium dosing is done in the solution thus obtained by flame emission photometry.

RESULTS AND DISCUSSIONS

a. Influence of land slope on pH

The slope of the land influenced to a small extent the pH value, ranging from 5.8 to 6.8. The pH value of 5.8 is influenced by fertilization with the slope land up to 5%, where the pH has a reaction on the depth of 0-20 cm of 5.8, respectively weakly acidic determined by the fertilizers applied, these having an acidic reagent (urea).

The value of 6.8 is found in the upper third of the slope, this value is due to the washing of the upper horizon following rainfall and the weak erosion process collaborated with a degradation, considering that the same cultivation technology and fertilization plan were applied on the same soil as on the plateau (*figure 1*).

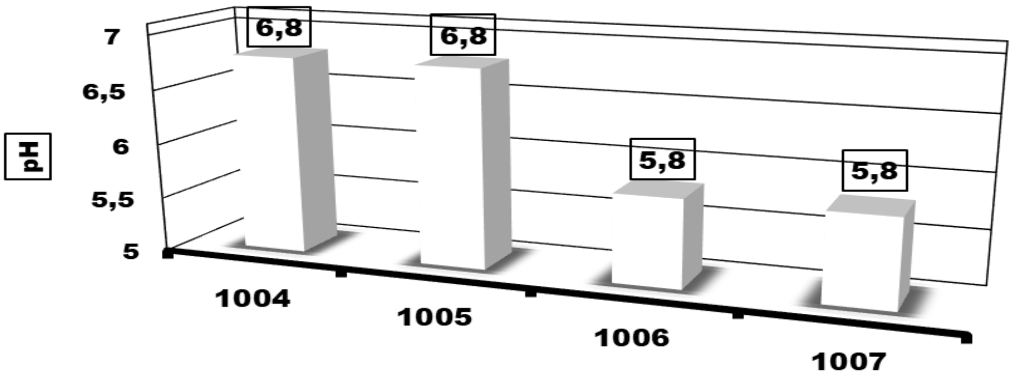

Figure 1 **Topographic plot 127a – pH value**

b. Mobile phosphorus content of plot 127a

Following agrochemical sampling it was found that phosphorus is poorly supplied to the upper third of the soil type. Agrochemical samples 1005 and 1006 are classified as poorly supplied and agrochemical samples 1004 and 1007 are classified as medium supplied with mobile phosphorus (*figure 2*).

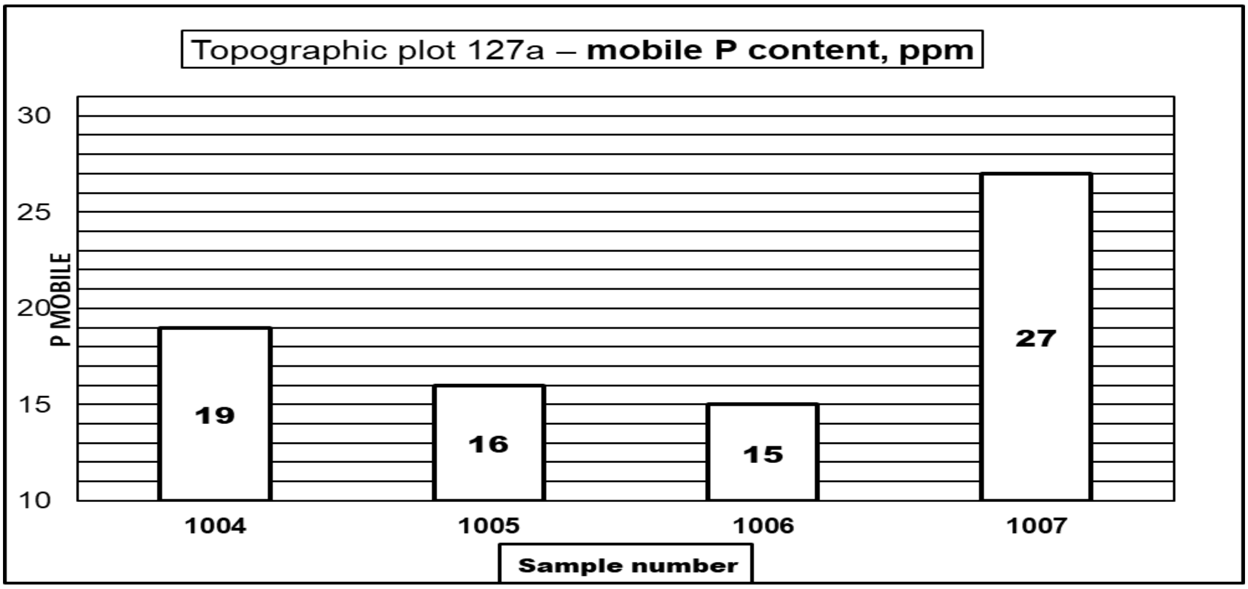

Figure 2 **Mobile P content (ppm)**

c. Mobile potassium content of plot 127a

Potassium is the most important cation for living organisms, performing numerous physiological and biological functions. In all four agrochemical samples taken, mobile potassium is in good and very good assurance, ranging from 195 to 218 ppm.

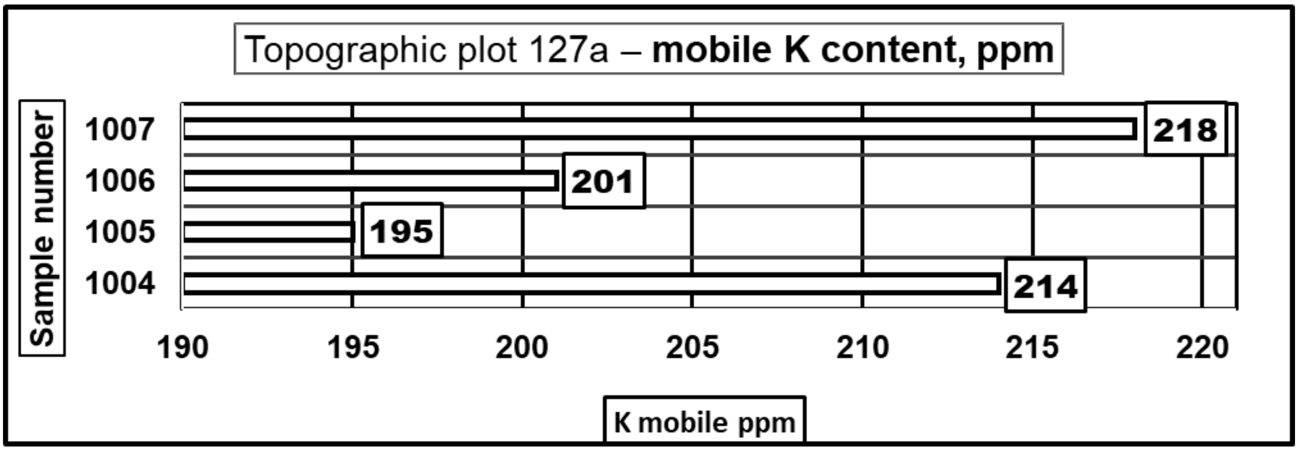

Figure 3 **Mobile K content (ppm)**

d) Secondary macro- and micro-nutrient content of plot 127a

Two agrochemical samples were taken on the surface of plot 127 for the determination of secondary macro and micro elements. One sample was taken from the slightly steeper slope towards the marginal area and one sample was taken where the land slopes up to 5%.

Laboratory tests showed the following:

- for the first sample, sulphur has a value of 10 ppm and is classified in the state of medium supply of sulphur to the soil, zinc is classified in the state of low supply with a value of 1.0 ppm, also the manganese content with a value of 14.7 ppm. The microelements Cu, Fe and B are classified in the medium supply state of soils with these elements;

- for the second sample, both secondary macroelements and microelements have values that are in a state of medium and good supply of elements, except for the zinc content which has a poor supply (*table 2*).

Table 2

Secondary macro- and micro-nutrient content of plot 127a

	Sulfur – IAS %		Zinc, ppm		Copper, ppm		Manganese, ppm		Iron, ppm		Boron, ppm	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Value	10.0	12.6	1.0	1.26	0.71	1.16	14.7	16,6	7,08	15,9	0,29	0,45
Supply status	middle	middle	low	low	middle	middle	low	middle	middle	good	middle	good
Mean value	11.3		1.13		0.94		15.6		11.5		0.37	
Supply status	middle		low		middle		middle		middle		middle	

CONCLUSIONS

The low supply status in mobile phosphorus content is due to the lower solubilization of phosphorus and its migration on sloping land due to higher flow precipitation in a short time.

On acidic soils, which have a phosphorus content of less than 36 ppm, phosphorus deficiency is likely to occur in young plants as the cold intensifies the phenomenon.

The pH value of 6.8 compared to the pH value of 5.8 is due to the slightly steeper slope towards the marginal area of the plateau, considering that the same works, fertilizations and treatments are applied on the same soil.

Regarding secondary macroelements and microelements, they have lower values towards the marginal area of the plateau, with a land slope of 7%, and where the land slope is up to 5%, the condition of secondary macroelements and microelements was medium and good, except for zinc content. The content of secondary macro- and microelements varies according to the slope of the land. The highest values were recorded on the plateau, where the land slope does not exceed 5%. The supply of these elements to the soil was recorded towards the edge of the plateau. Zinc content supply was low in both samples, ranging from 1.0 to 1.26.

ACKNOWLEGMENTS

This research is co-financed by the European Regional Development Fund through the Competitiveness Operational Program 2014 – 2020, project “Establishment and implementation of partnerships for the transfer of knowledge between the Iasi Research Institute for Agriculture and Environment and the agricultural business environment”, acronym “AGRIECOTEC”, SMIS code 119611.

REFERENCES

Berca M, 2008 - *Managementul integrat al nutriției plantelor*. Ed. Ceres, Bucuresti.

Bergman W, 1992 - *Nutritional Disorders of Plants*. Gustav Fischer Verlag. Jena, Stuttgart, NewYork.

Borlan Z, 1994 - *Fertilitatea si fertilizarea solurilor.* Ed. Ceres, Bucuresti.

Burlacu G, Popescu A, Maravela V, 2007 - *Rezultate ale cercetărilor în domeniul folosirii raţionale a îngrăşămintelor.* Analele I.N.C.D.A. Fundulea, LXXV: 287-307.

Ciepiela GA, Jankowska J, Jankowski K, 2012 - *The efficacy of mineral and organic nitrogen in fertilization of meadow sward.* Fragmenta Agronom., 9(2):17-26.

Davidescu V, Davidescu D, 1999 - *Compendiu agrochimic*. Ed. Academiei Romane, Bucuresti.

Gerge, J., **2022 -** *The centrl role of soil organic matter in soil fertility and carbon storage.* Soil Syst., 6(2) 33.

Hera CR, Borlan Z, 1980 - *Ghid pentru alcătuirea planurilor de fertilizare.* Ed.Ceres, Bucuresti.

I.C.P.A., 1981 - *Methodology of agrochemical analysis of soils to determine the need for amendments and fertilizers.* Bucharest–Romania, volume III.

Kruczek A., Szulc P, 2000 - *The influence of foliar application of urea on N uptake and N utilization by maize.* Fragmenta Agronomica, 17(3):18-29.

Kwabena NA, Ngombe J, Kaitibie S, 2022 - *A Dose–Response Analysis of Rice Yield to Agrochemical Use in Ghana.* Agriculture 2022, 12(10), 1527.

Lixandru G, 1990 - *Agrochimie.* Ed. Didactica si Pedagogica, București.

Lixandru G, 2006 - *Sisteme integrate de fertilizare în agricultură.* Ed. Pim, Iași.

Lăcătușu R, 2000 – *Agrochimie*. Ed. Helicon, Timișoara.

Matei G, 2014 - *Fitotehnie*. Cereale şi leguminoase. Vol. 1, Edit. Sitech, Craiova.

Stošić M, Brozović B, Tadić V, Stipešević B, Jug D, 2017 - *Effect of soil tillage and nitrogen fertilization treatments on winter wheat grain yield.* Romanian Agricultural Research, 34:105-111.

Sparovek G, Schunk F, 2001 - *Soil and Tillage research*. Science Publishers, International Soil Tillage Research Organization, Elsevier, Brazil.

Madjar R, Davidescu V, 2009 – *Agrochimie.* Ed. Academiei Romane, Bucuresti.

Małecka I, Blecharczyk A, 2005 - *The efficiency of nitrogen fertilization in different tillage systems.* Fragmenta Agronomica, 22(1):503-511.

Mulvaney RL, Khan SA, Ellsworth TR, 2009 – *Syntheyic nitrogen fertilisers deplete soil nitrogen: A global dilemma for sustanaible cereal product.* ISSN 0047-2425.

Zotarelli L, Scholberg JM, Dukes MD, Muñoz Carpena R, 2008 - *Fertilizer residence time affects nitrogen uptake efficiency and growth of sweet corn.* Journal of Environmental Quality, 37:1271-1278.

https://www.statista.com/statistics/438967/fertilizer-consumption-globally-by-nutrient/.

https://www-pub.iaea.org/MTCD/publications/PDF/te1164_prn.pdf.