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SOIL SCIENCES

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IDENTIFICATION OF AGRI-FIELD CONTOURS BY UAV OF AERO-PHOTOGRAPHY TECHNIQUES

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Abstract

The article considers the methodical approach of determining the soil contours on the basis of aerial photography from an unmanned flying apparatus (drones). On the basis of Brown's model, a map of soil contours is based on aerial photographs taken from the camera of the household segment. A methodical approach to the analysis of soil contours using all three channels of the RGB model is shown. The algorithm describes the numerical values of each soil contour of the study polygons. Described are all polygons that were used for aerial photography. As a result of experience gained, it was found that visual separation of soil-contours is only appropriate with perspective snapshots.

Key words: *agri-field, soil contours, aero-photography techniques.*

INTRODUCTION

As of 2014, Ukraine has no real policy of land monitoring and inventory stock-registration yet. This fact, and a necessity to improve this situation, are evidenced by a series of documents issued by National Council for Safety and Defence of Ukraine (RNBO), and the Decree no.572/2013) by the President of Ukraine. However, this necessity is not a spontaneous effect, for it had been accruing gradually in the course of decades. Soviet Government, aided practice of preparation and formatting agricultural, purpose soil maps in the former USSR (being now of a great concern by present-day Ukrainian agencies, enterprises, institutions and individuals) was suspended in late 1970-ies.

Due to some political and economic reasons, such important efforts were never renewed, nor lots of maps were updated as yet. Accuracy and, moreover, trustworthiness of those 30 years old maps are now obsolete, while, by opinion and estimations of land cadastre experts, their ability to support an assessment and evaluation of agricultural lands and soils is now doubtful (Canash, 2008, 2013). Therefore, a need of implementing relevant studies over the territory of Ukraine becomes a must in oncoming years. However in Ukraine, this task is somewhat problematic due to lack of up-to-date remote sensing equipment, capable of acquisition and transmitting actual soil cover status data to ground operator. In other words, the Ukraine acknowledged space actor does not avail any satellite on orbit. Spatial wide scope data on actual status of national soil cover are only available from overseas paid service space &satellite agencies. This factor still adds to complicacy of the process of getting the urgent data in operative manner. As a result, an acutely needed information is available only with long delay and more than often from archive sources, followed by under fragmentary imaging of any piece of territory of interest in Ukraine. Elaboration of methodology approaches to update and harmonize these issues requires formulation of modern solutions nationwide, from local agencies to Governmental institutional levels.

A subsidiary and, in some cases, an alternative method of obtaining the soil cover status data is aerial photography technique. Regretfully, no massively planned aerial aircraft-aided surveys of soil cover are practiced nowadays in Ukraine, mostly due to deficiency of relevant equipment and aero-photo-lab facilities as yet.

On the other hand, good news appear in recent years that gradually becoming popularized is a technology of aero-photo shooting by aid of unmanned flying vehicles (UAVs) or air model planes (DPLAs), being advantageous to handle and service relatively small (up to 20,000 ha) areas a day. These hand-launched craft do really complement the Great Aviation, which is too huge to barrage over mosaic pattern of agri-fields (Sliva, Demidenko, 2011; Solokha, 2010).

Purpose of this paper is to manifest effectiveness and demonstrate facts and actual achievements gained in operating this kind of equipment accomplished recently in several regions of Ukraine.

Tasks included: creating the methodology and techniques of agrifields' contours status identification; verification of elaborated methodology and techniques' effectiveness by on-ground contact methods; analysis and evaluation of relevant software versions to be used for elaboration of these methodology and techniques etc.

MATERIALS AND METHODS

Objects of practical studies:

❶ ***Kirovohrad Oblast, Novo-Archangelsk region.*** Land-shooting with DPLA/UAV - craft over the rural territory around Novo-Archangelsk-Torgovitsa-Levkìvka-Sabovo hubs. Geographical coordinates of test-fields centers:

- field no.1: 48.624979 N, 30.798207 E;
- field no.2: 48.627191 N, 30.804985 E;
- field no.3: 48.622785 N, 30.821947 E;
- field no.4: 48.518709 N, 30.802392 E.

❷ ***Kyiv Oblast, Bohuslavsky region.*** Land-shooting with DPLA/UAV - craft over the rural territory around Dibrovka-Huta-Isayki settlements. Geographical coordinates of the test-field center:

- field no. 5: 49.459964 N, 30.796618 E.

❸ ***Kharkiv oblast, Chuhuyiv region.*** "Slobo-zhansky" pilot field. Geographical coordinates of the test-field center:

$49^0 43'2674''$N. $36^0 55'2333''$E.

1st phase of work: *Research type:* classical in the field of soil science. *Way of research:* contact. *Actions within 1st phase of research:* primary cut-outs and reference pit dug-outs.

2nd phase of work: *Research type:* the remote. *Way of research:* contactless. *Actions within 2nd phase of research:* air photographing from unmanned remotely piloted super-light air vehicle (DPLA/UAV).

Spectral data were registered using Pentax W60™ camera on board the UAV (Zinčenko, 2011; Sečin et al., 2011). Survey shooting was conducted from different positions and directions of sight-alignment, within 9:30AM to 17:00PM daily in October-November 2013. The UAV average flight altitude over test fields made up 80-100 m high. The air - shooting survey has been practiced intendently under numerous different conditions of various sunlight and cloudy sky illumination levels, with purpose to elaborate methodological data - based solutions to cope with problems that affected accuracy and trustworthiness of the project results.

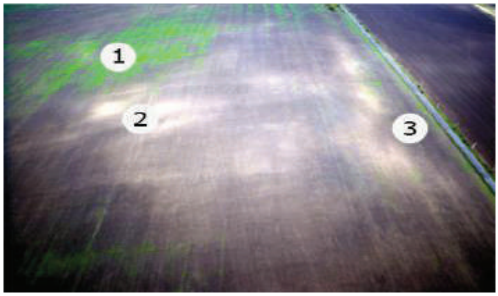
In early practices, contours of fields to be surveyed were flown over at different altitudes and in the geometrically true directions, to systematically cover the overall site area. It soon became clear that such a systemic approach is very bore some and too lengthy (~5 hours for every 100 ha (!). Therefore, route patterns were improved. In a thus improved pattern, a normal route is a combination of several intensive series of upward and downward spirals over a test field. This new approach helped eliminating errors in determining the test-field contours under cloudy sky or at different angles of Sun-inclination, and radically reducing the shooting time (now up to 10 min. per every 100 ha). In this manner, a single flight of DPLA/UAV facilitates ~120-150 photo-shots a session. For the purpose of creating orthophoto maps, the techniques of „stitching together" the aerial photographs (based on Brown's model for correction of image-distortions in pictures) was used. From now on, picture images are processed in a series block. Design of these serial blocks includes: aligning the picture images, constructing ortho-photo-map schematic geometry bases, building plan-texture and consequent saving the project schematics.

The ortho-photo-map is built using both planned and perspective type snapshots (whereby camera shooting axis is 90^o only, or scanning between 90° and 60°), correspondingly. Determining the land contours (or non-uniformities) of a test-field was started with a „how-do-you-do” flight by DPLA/UAV over a territory examined. Consecutively, using a set of perspective snapshot images, the contours were identified that still needed verification checks. Having identified field - contours visually, operator has to dig out a chain of standard reference pits, and to ensure log-booking of morphological indices of soil profile. Upon confirmation of land contours, authors proceeded with „stitching the snapshots”, constructing the ortho-photo-map and finally binding up geographically thus derived entries into the [ArcInfo] and [Mapinfo] based on the GIS- package.

RESULTS AND DISCUSSIONS

Both visual inspection and air survey techniques agreed with fact that land contours differ in colour-tint of their images, which is presumably an impact of granular composition and degree of moisture-supply locations on humus accumulation intensity. A similar effect is evidenced by anthropogenic intervention resulting in soil erosion or even soil-plunder, caused by pipelining, electric power and communication cable-engineering provisions.
It was found that perspective images require visual separation of land contours (spots ①②③ in Figure 1), where by the view (a) is an original snapshot, view (b) is the same image after contrast correction. Owing to this innovative approach, soil-cover defects are clearly expressed and easily identified.

a.

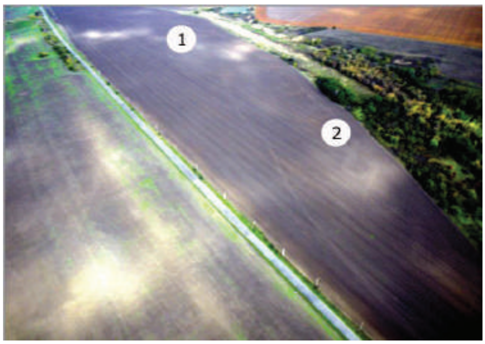


b.

Figure 1. Facts of soil-contour fixation on test-field no. 1

Soil-contours possess the following characteristics:
① - the agricultural vegetation in positive water-supply area, with powerful and thick-humus soil cover.
② - mezo-xero-morphical area on convex side of a slope, under relatively dry conditions.
③ - anthropogenic intervened soil-layer (by electric cable sub-soil construction).

a



b

Figure 2. Facts of soil-contour fixation on test-field no. 2

The test-field no. 2 possesses an eastward (3^0) slope. Identified contours possess typical indications of runoff towards moisture accumulation areas (①,②) (Figure 2).

Soil-cover with pale spots is a reflexion of typical chernozem soils of various degrees of xero-morph characteristics, together with eroded soils complex.

The test-field no. 3 possesses a westward (3^0) slope. Studies revealed habitats of soil bodies under cover of agri-vegetation (Figure 3).

a.

b.

Figure 3. Facts of soil-contour fixation under agricultural plant (soybean) on test-field no. 3

Clearly traced hereby are contours of soy, corn and wheat. On mezo-xero-morphical and heavy-xero-morphical soil areas, the above said agricultural vegetation is in non-uniform status of regress, ripening etc. Many researchers believe that task of soil contour identification under cover of vegetation is a difficult (if ever possible) challenge (Solokha, 2010). Data available with author (Solokha, 2013) still support an idea that usage of phyto-indication method for soil contour fixation is promising to further discoveries.

Characteristic manifestations of xero-morphous flushed-off contours appear in optical band as spots of generally increasing spectral brightness (SB) in all channels of the RGB model. Just for comparison: contours of weed areas possess higher SB-indices in G-channel. At any rate anyway, spectral values of background on all test-fields indicate 70-78 units in all three channels. Hence, contours of xero-morph-eroded soils in optical band are easily identified.

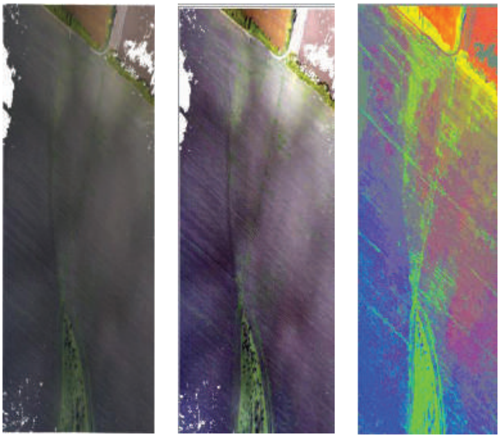
Research study results show that using aero monitoring techniques, one can define micro-relief of any field, as well as hydrological regime characteristics of any its portion. To this end, spectral analysis of UAV-borne photos of winter wheat, shot at "Slobozhansky" pilot field (Kharkiv oblast, Chuhuyiv region) in late April, 2013, has revealed a brighter tinted spot against the dominant colour of all over the test-field. Deficiency of nitrogen plant nutrition, whose diagnostic indication appears as a lowered contents of chlorophyll in vegetative plant organs, could have been caused by activation of dentrification processes in this field-portion. These effects typically occur under anaerobic conditions in over moisture soil cover. In respect of above-mentioned spot, a somewhat lowered micro-relief was identified in contrast to the total surface of the field, whereas supplies of productive moisture stock, within 1-meter deep layer of soil (as of May 23, 2013) exceeded this index for plain-level area by 24 mm.

This implies that early in spring-time, there in the lowered micro-relief area might have occurred appropriate conditions for evolution of dentrification processes, that have eventually led to losses of nitrogen gaseous from soil and decrease in contents of mineral nitrogen compounds. In this manner, usage of aero-monitoring methods for identification of crops' status allows one to manipulate scientifically substantiated agrochemical techniques and to improve efficiency of mineral fertilization by 10-15%, owing to prevention of non-productive losses from nutrient substances.

Let's, for example, consider why not to try the following option: during early spring-time fertilizing of winter grain crops, in area that suffers from low micro-relief, one can apply nitrogen fertilizers in smaller doses than on the rest of the field.

Instead, after some time (i.e. when the soil obtains optimal moisture level and the risk of gaseous nitrogen losses decreases), the prevailing amount of remaining nitrogen fertilizers can be delivered uniformly to fertilize the plants roots.

Now, back to the air shooting campaign: meteorological variations were non-stop (24 h) monitored, especially including cloudy conditions that typically affect quality of aerial snapshots imaging. In space-borne surveillance practice, clouds typically disable chances to conduct identification efforts in optical band of EM-waves. In our project, aero-photo survey was carried out below level of clouds (that hovered at heights from 800 m to 1000 m, visually). To beat harmful effects and probability of image distortions, authors employed their method of spectral processing of thus acquainted ortho-photo maps in environment of [ErdasImage™ - 9.1] (Figure 4).



(a) (b) (c)

Figure 4. Sequence of induced ortho-photo map transformations, to reduce an impact of the „cloud-ceiling" on results of soil-contours identification

This has enabled authors to obtain ortho-photo plans at minimum impact of meteo-factors on soil chart-schemes (Figure 5). Individualization of soil contours was done using colour / tint contrasts of soil cover on slopes, under vegetation, etc. Ready-made orto-photo-plan was loaded into GIS-package to be further processed by standard cartographic tools, to finally obtain a commercially high-quality chart-scheme.
View (a) - shown is field no. 4 (fragmented), whose image was obtained by virtue of [PhotoScan™] ortho-photo-mapping software resource. View (b) - contrasting the ortho-photo-plan brings to amplification of „cloud-ceiling" outlines. View (c) - result of spectral processing of the ortho-photo-plan, manifested by hill-slope coloring and off-field thalweg-pattern.

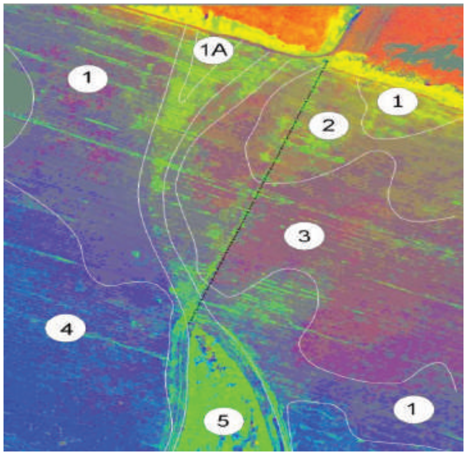


Figure 5. Orto-photo-plan based on the imaging of soil-cover contours:
❶ - typical chernozem; ❷ - typical chernozem black soil, weakly-xero-morphical; ❸ - typical chernozem black soil, mezo-xero-morphical; ❹ - typical chernozem black soil, weakly-xero-morphial; ❺ - the black soil chernozem layer deposited on diluvium sub-stratum; **1A** - typical chernozem of elevated moisture supply; ***Black dotted line:*** an obsolete old-time valley road

When shooting in autumn weather with heavily clouded skies, soil-cover contours[(*)] were identifiable without extra efforts of contrast and spectral processing (Figure 6).
[*]***Note:*** *especially belonging to xero-morph-eroded and light-granulometric content soils.*
Shooting over the same areas in sunny weather has only confirmed the truth of that hypothesis (Figure 7).
View (a) - a convex slope over 5^{o}. Light-brown stains reflect flushed-off contours.
View (b) - the rest of the no. 5 field with plain relief expressed by better moisture-supply area on basic relief.
Both in Kirovohrad and Kyiv district areas, contours of xero-morph-eroded soils possess similar spectral brightness indices.
In other words, spectral characteristics of soil-contours in the forest-steppe zone of Ukraine have common features, notwithstanding of latitude dependence amount of solar radiation income.

a.

b.

Figure 6. Field no. 5 (Kyiv district, Boguslav region). Shooting with DPLA/UAV under solid nebulosity

a.

b.

Figure 7. Field no. 5. Control shooting with DPLA/UAV in sunny weather

CONCLUSIONS

As a result of experience gained, it was found that visual separation of soil-contours is only appropriate with perspective snapshots. Identification of soil-contours occupied by vegetation cover is facile by aid of remote techniques; whereby factors of special importance are status of vegetation, time of shooting and latitude. Employment of Brown model at plotting soil- chart-plans and schemes, as well as identification of agri-crop contours, opens broad prospects. Brown model implementation is available with [PhotoScan] software resource. However, whilst shooting land objects of specific features (like cross country forest strips of agricultural buildings, structures etc.), there exist certain limitations against application of Brown model. When plotting the Brown model derivation, images undergo distortion and thus, this technique is regretfully helpless at measurement of specific soil contour areas. Xero-morph-eroded soils possess a significant spectral brightness, even being occupied by any agri-vegetation. Values of SB-index range between 80 and 130.

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RESEARCH REGARDING THE POSSIBILITY OF FERTILIZATION OF ARABLE LAND FROM LOCAL MANURE SOURCES USING GIS TECHNOLOGIES

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Abstract

Currently, in the Republic of Moldova about 94.4% of livestock is in small scale farms (small holdings), which makes it difficult to collect, store and use produced organic wastes. As a result, huge quantities of unused manure are thrown to the edge of roads, ridges, rivers, which leads to soil and water pollution. At the same time, soils involved in agricultural production are affected by various degradation processes, most of which are related to the lack of organic material and nutrients. The goal of the research was to reveal the possibility of manure use at local scale and to determine suitable sites for utilization of manure as organic fertilizer on example of Grinauti village, Riscani district in order. The selection was made by use of GIS technologies, namely through construction of GIS based decision model using Boolean logic. For decisional model construction were used eight decisional criteria relevant to study goal: soil bonitet; soil mobile phosphorus content; slope; proximity to access ways; proximity to springs and wells; proximity to localities and sheepfolds; proximity to aquatic objects; land use. In the result it was obtained a map of favorable places for use of manure. According to obtained decisional model 77.9% of arable areas are suitable for manure application.

Key words*: Boolean model, GIS, manure.*

INTRODUCTION

The problem of the use of manure in the Republic of Moldova is that about 94.4% of the livestock is in the smallholdings of the population, which makes it difficult to collect, store and use manure. According to the statistical data, about 400-500 thousand tons of manure per year are formed in the Republic of Moldova (Statistical yearbook, 2017), of which only 150-200 thousand tons were used annually.

As a result, big quantities of unused manure are thrown to the edges of roads, ravines, small rivers, leading to soil and surface or underground water pollution [Siuris, 2011 (1); Toma, 2008]. At the same time, manure is a complex fertilizer that contains all the elements necessary for plant growth and positively influences the physical condition and soil fertility [Siuris, 2011 (2); Toma, 2008].

Organic matter in manure is an important source for fertility and humus content recovery in soils, especially eroded ones [Siuris, 2011 (2); Toma, 2008]. It has a positive effect on the physical properties of soils, the ability to filter and retain water in soils, reducing water losses and attenuating drought (Toma, 2008). Manure fertilization also reduces water consumption by 25-35% to form the harvest unit (Andries, 2011). When manure decomposes, carbonic acid is formed. It contributes to the passage of nutrients from less soluble forms into easily soluble and accessible for plants forms. Some of the carbonic acid is eliminated in air and is assimilated by the plants. Soil fertilized with manure heats better, and temperature deviations are feet less [Siuris, 2011 (1)]. It has been established that manure produced in the Republic of Moldova is more qualitative, having a lower moisture content and a higher content of nutrients, compared to that obtained on podzolic soils or gray soils (Rusu and Plamadeala, 2011).

The purpose of the research was to highlight the possibility of using animal waste as an organic fertilizer to minimize environmental pollution under existing socio-economic conditions based on a concrete case study - Grinauti commune from Rascani district.

This research work was carried out with the financial support of Academy of Sciences of

Moldova under the project for young researchers No. 35/IND „Selection of suitable sites for manure application using Geographical Information Systems (GIS) technologies. Case study of Grinauti village, Riscani district", project leader PhD Ciolacu Tatiana.

MATERIALS AND METHODS

The research was carried out in the northern part of the Republic of Moldova, Rascani district, Grinauti commune.

To achieve the purpose of the research, a decision model was built on the basis of the Multicriteria Data Analysis (MDA) in the GIS environment. The MDA is meant to combine several factors or decision criteria according to a pre-established procedure (Malczewski, 1999). Specialized literature describes multiple and varied methods of constructing decision models of different complexity (Malczewski, 1999; Malczewski, 2006; Voogd, 1983). For this study was used one of the simplest models-combination based on Booleane algebra, a model known as the "logical Boolean model" which is performed by multiplying the criteria represented in the binary form (O'Sullivan and Unwin, 2010):

$$S_i = \prod_{j=1}^{n} Cr_i^j \qquad (1)$$

where:

S_i - represents the index of favorability for spatial unity *i*;

Cr_i^j - the value of criterion *j* for space unit *i*;

n - number of criteria.

Input criteria in the model are zero if the manure is not allowed for the given space unit and one when allowed. The same interpretation have the result of the Boolean decision model.

In order to build the decision model, the following factors relevant to the purpose were used: land use; proximity to localities and sheepfolds; proximity to access roads (asphalt road, country road); proximity to springs and wells; proximity to water areas (lakes, rivers, ravines); the soil quality represented by soil bonitet; slope; the amount of phosphorus in the soil. The input data in the decision model were generated taking into account the following considerations:

The content of mobile phosphorus in soils. There were no restrictions on the content of mobile phosphorus in soils because its content in the agricultural soil of the commune in most cases was below the optimal level of 3.0-4.5 mg/100 g of soil (Pedologic report…, 2005).

Slope degree. According to EU recommendations for Good Agricultural Practices, slopes of more than 15% represent a major risk of soil erosion. Thus, land with a slope of more than 15% was considered a restriction. The slopes were generated through the *ArcGIS Slope tool* based on the digital relief model. The digital relief model was generated through the *Topo to Raster tool* of ArcGIS based on the digitized curves and digits on the 1: 25000 topographic map available on the Land and Cadastre Agency of Moldova website.

Soil bonitet. On the basis of the soils pedological report and soil bonitet (Pedologic report…, 2005), it has been decided to consider areas favorable for manure application - areas where *soil bonitet* is higher than 50 points. Soils with *bonitet* of less than 50 points from studied area are severe and very severe eroded soils, hydromorphic or dynamomorphic soils, which are not recommended for application of fertilizers.

Proximity to access ways. For aesthetic reasons, it has been decided to use manure on land at a distance more than 25 m from roads (Basnet et al., 2001). Roads have been digitized from orthophoto images. *Buffer and Clip tools* have generated inadmissible areas for manure application.

Proximity to springs and wells. According to the recommendations developed by the Academy of Sciences of Moldova and the Ministry of Agriculture and Food Industry of the Republic of Moldova (Andrieș et al., 2005), it is not recommended to apply manure within the range of at least 50 m from the drinking water sources. The data on the spatial location of the springs and wells were collected with GPS in the field. Restrictions on the application of manure to the given criterion were generated in the same way as in the previous case.

Proximity to localities and sheepfolds. Based on the experience of other states, it was decided not to use manure within the 250 m radius (Basnet et al., 2001). An additional argument for using a buffer zone for localities is that it will most likely reduce the impact of pollutants on aquifers near the locality. The localities and sheepfolds were extracted from the land use map. Inadmissible areas for manure application were generated as in the previous cases.

Proximity to aquatic objects. According to the Law on Strips and Areas for the Protection of Rivers and Lakes no. 440-XIII of April 27, 1995, art. 7 (Republic of Moldova), the width of riparian water protection strips is 100 m for large rivers and at least 20 m for small rivers (Low nr. 440 from 27.04.1995, Republic of Moldova). Thus, the land at a distance of less than 100 m from Raut and 25 m from the rest of the small rivers was considered inadmissible, and in the case of the lakes - 50 m. On the territory of the commune is located a wetland, so it was decided to impose here the same restrictions as in the case of small rivers.

Land use. Given the fact that fertilizers can be applied only on arable land, all other categories were considered inadmissible.

The decision criterion and the Boolean logic model were represented by raster spatial data with a resolution of 10 meters.

For the digitization of the initial spatial data (land use, phosphorus content, roads, rivers, lakes, curves and level elevations), the Quantum GIS open source GIS software was used. Geoprocessing and construction of the Boolean logic model was made in the licensed ArcGIS 9.0. The cartographic material was prepared on the basis of data available at the Institute of Pedology, Agrochemistry and Soil Protection „Nicolae Dimo" and the National Geospatial Data Fund administered by the Land and Cadastre Agency of Moldova.

Calculation of the amount of manure produced annually in the locality was performed using the parameters of manure accumulation in smallholdings published by Rusu (Rusu et al., 2012). The author proposes generalized manure indexes based on analysis of bibliographic sources.

Quality of manure usually varies according to the age and health status of animals and the nature of the fodder. In our research we used the average values of manure composition with natural moisture prepared for application (fermented). These values were obtained as a result of generalizing the multiannual data accumulated by the Organic Fertilizer Laboratory and Soil Fertility of IPASP „Nicolae Dimo" and published by Rusu and Plămădeală (Recommendations…, 1994; Rusu et al., 2012).

RESULTS AND DISCUSSIONS

Study of the present situation regarding manure generation in the Grinauti commune, Rascani district

At the time of the research on the territory of Grinauti commune there were no functional livestock complexes for animal breeding. All the animals were maintained in small scale farms (smallholdings). No individual or communal platforms for the collection of manure were found on the territory of the commune. So, in our research, only manure from smallholdings and poultry manure were studied. The amount of manure produced in a locality depends on the species, breed, age of the animals, their number and the length of the stabling period. The data on livestock and poultry in Grinauti commune were provided by the commune's town hall (Table 1). The annual amount of manure produced in the commune was calculated according to the Rusu method (Rusu et al., 2012) using average valuesfor each species, obtaining the following results:

Table 1. The amount of manure accumulated annually in the village of Grinauti, Rascani district

Species	Number of animals	The amount of manure accumulated in one year		
		from 1 animal	from all animals	share of total volume, %
Cattle	252	7.9	1991	56.9
Sheep and goats	702	0.5	351	10.0
Swine	320	1.8	576	16.5
Horse	36	5.1	184	5.2
Birds	8000	0.05	400	11.4
Total			**3501**	100

Site selection

The selection of sites for manure requires consideration of all the environmental factors indispensable for the use of this fertilizer. So, it is necessary to have land use data, soil condition, relief, hydrographic network of studied territory, existing road network and residential areas.

Figures 1-8 shows the input factors for the Boolean logic model represented in the binary form.

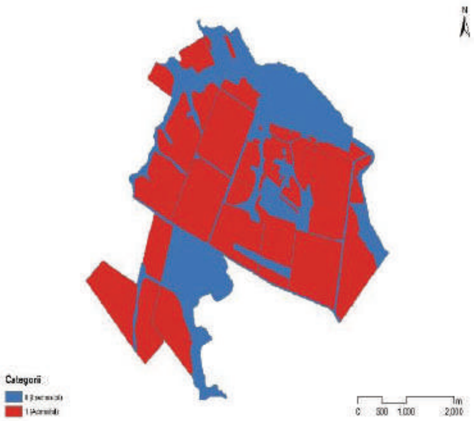

Figure 1. Entry factor Soil bonitet

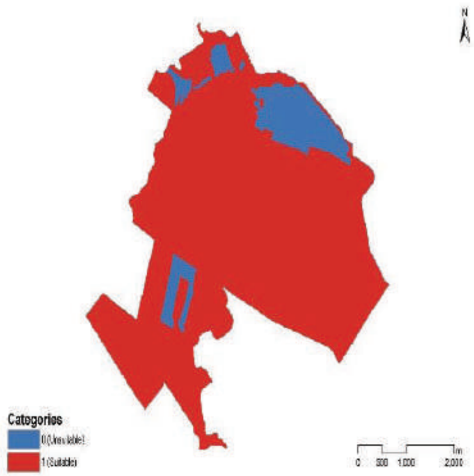

Figure 2. Entry factor Mobile phosphorus

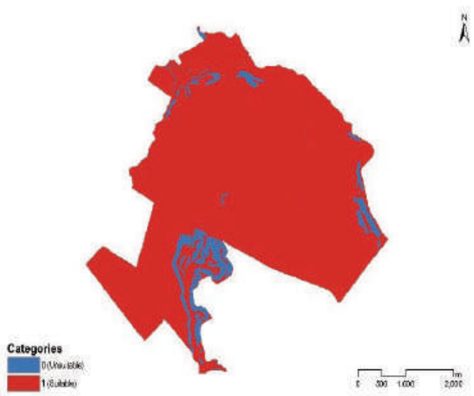

Figure 3. Entry factor Slope

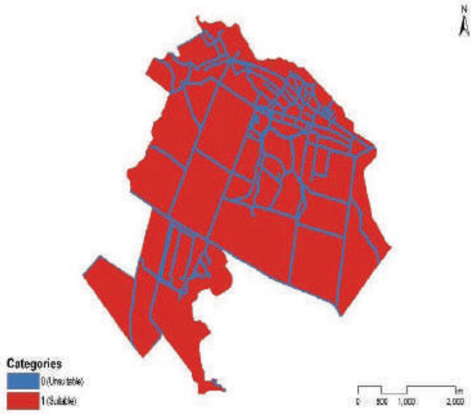

Figure 4. Entry factor Proximity from access ways

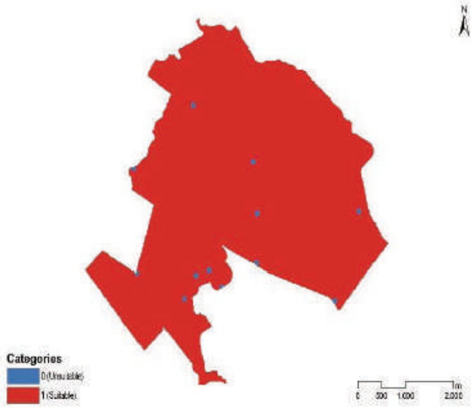

Figure 5. Entry factor Proximity from springs and wells

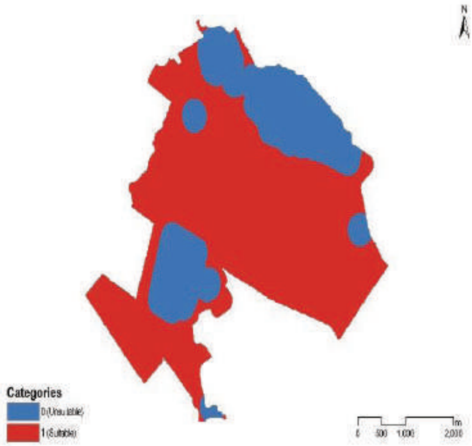

Figure 6. Entry factor Proximity to localities and sheepfolds

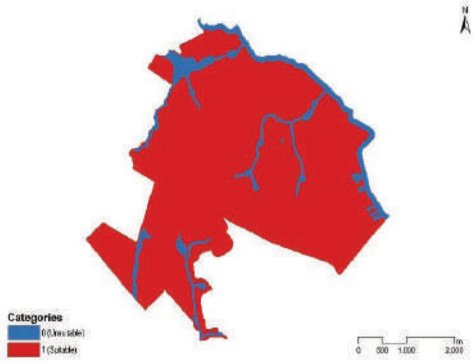

Figure 7. Entry factor Proximity from aquatic objects

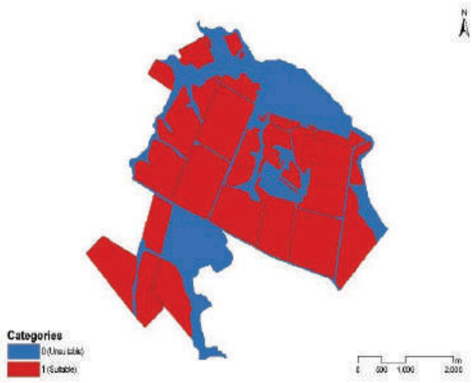

Figure 8. Entry factor Land use

The Boolean decision model was generated using the *Raster Calculator tool* based on the formula and input factors shown above. Applying the described methodology resulted in the decision model shown in Figure 9.

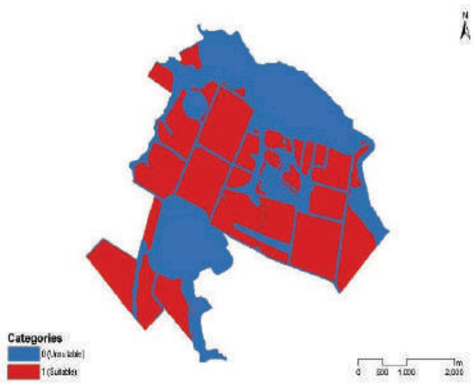

Figure 9. The decision model based on Boolean logic

According to the Boolean decision model, approximately 77.9% of the area of arable land is suitable for the application of manure as an organic fertilizer (Table 2).

Table 2. Suitable areas for the application of manure reported at arable land area

	m^2	ha	%
Arable lands	12856371	1285.64	100
Suitable area	10013200	1001.32	77.89

Calculation of organic fertilizer doses

Application of organic fertilizers in soils requires optimal doses calculated basing on the needs of plants and maximum admissible quantities that prevent environmental pollution. European Union legislation regulates the maximum allowable nitrogen intake because it can be easily leached from the soil (Council regulation…, 1991). Exceeding these doses may result in pollution of groundwater and surface water. According to this Directive, established in 1991, the annual nitrogen limit is 170 kg N/ha.

Maximum dose of fertilizer in this case is calculated according to the following formula:

$$D_{max} = 17 : N \qquad (2)$$

where:

D_{max} - dose of manure with the natural moisture content, t/ha;

N - total nitrogen content in fertilizer, % from mass with natural moisture content;

17 - coefficient that consider the maximum allowable nitrogen dose - 170 kg N/ha and recalculation of the fertilizer from kilograms in tonnes (Rusu et al., 2012).

According to our calculations, in a smallholding from Grinauti commune is produced mixed manure with a weighted average nitrogen content of 0.74%.

By replacing this data in formula 2 we obtain the maximum dose that can be applied in a round in the field:

$$D_{max} = 17 : 0{,}74 = \mathbf{23\ t/ha}$$

According to the literature, it is recommended to apply manure once every 4-5 years on the same land. In the case of soils with low humus content (<2%) or eroded - once in 3-4 years (Andries, 2011; Recommendations…, 1994). With the total amount of manure produced annually in the commune (3501 t) and applying this fertilizer every five years (for example in a five-field crop rotation), we can fertilize 761 ha of agricultural land by applying the maximum allowable dose.

The maximum allowable dose determines the amount of nitrogen that can be applied over a 12-month period on a soil. In practice, however, we do not need to apply maximum doses, but only those necessary for crop plants - optimal manure doses.

Optimal dose of manure introduced for high and qualitative crops is calculated depending on the nitrogen content in fertilizer and the needs of the crops by the following formula:

$$D_{opt} = P \div (10N) \quad (3)$$

where:

D_{opt} - the optimum dose of manure required for the expected harvest, t/ha;

P - the amount of nitrogen planned for incorporation, kg/ha;

N - total nitrogen content in fertilizer, %;

10 - the coefficient of recalculation of the fertilizer from kg/ha in t/ha.

According to the data on the average consumption of nutrients, for the production of 1 tonne of production are necessary: winter wheat - 33 kg of nitrogen, corn - 23 kg N, sugar beet - 40 kg N, sunflower - 40 kg N, tomatoes - 3 kg N, cabbage - 4 kg N, potato - 7.5 kg N, onion - 4 kg N (Recommendations, 2001; Recommendations, 2012; Rusu, 2005).

The amount of nitrogen required per hectare is calculated by multiplying the expected yield to nitrogen consumption per 1 tonne of production (Table 3). Optimal manure for the expected yields were calculated according to formula 3.

Thus, in order to obtain the expected crops for corn, sugar beet and sunflower fertilizer doses between 15.5-16.2 t/ha are required. If the nitrogen dose necessary for a crop is higher than the annual limit (in our case 23 t/ha), for example cabbage and potatos (Table 3), the maximum allowable dose will be applied to prevent nitrate pollution.

Table 3. Nitrogen requirements of crops and manure doses

Crop	Nitrogen content in manure, %	Nitrogen consumption per tonne of production, kg	Expected harvest, t/ha	The amount of nitrogen required per hectare, kg	Dose of manure, t/ha
Winter wheat	0.74	33.0	4	132	17.8
Corn	0.74	23.0	5	115	15.5
Sugar beet	0.74	40	30	120	16.2
Sunflower	0.74	40.0	3	120	16.2
Tomatoes	0.74	3.0	50	150	20.3
Cabbage	0.74	4.0	50	200	27.0
Potatoes	0.74	7.5	40	300	40.5
Onion	0.74	4.0	30	120	16.2

CONCLUSIONS

As a result of the research, a decision model based on the Boolean logic in the GIS environment was generated in order to determine suitable areas for the application of manure as organic fertilizer on the lands of Grinauti commune, Rascani district. The decision model was executed on the basis of eight decision criteria relevant to the purpose of the research. Basing on the decision model, it was established that manure can be used on a total area of 1001.32 ha, which represents 77.89% of the arable land area.

The maximum dose of manure with total nitrogen content of 0.74% that can be applied on studied territory is 23 t/ha.

The manure produced every year in the commune and applied once in five years in dose of 16 t/ha is sufficient for the fertilization of 1090 ha, so it is real to fertilize all the suitable area of the agricultural land in the commune.

ACKNOWLEDGEMENTS

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STATISTICAL ANALYSIS OF THE SUSTAINABLE AGRICULTURAL LANDS USE AND FERTILE IRREVERSIBLE LOSS OF SOIL WHICH ARE WASHING FROM VERSANTS OF RURAL AREA

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Abstract

The developing sustainable agriculture (ecological) promoting sustainable production systems, diversified and balanced, in order to prevent the pollution of the crop and the environment. In order to extend the system of sustainable agriculture in the Republic of Moldova, national legislation has been established on the production, processing and capitalizing on agri-food products and special attention is given to soil quality - plant life. The aim and tasks of rural research were to: Determine the washed soil mass on the slopes based on the average statistical parameter data depending on the chemical properties (humus content) and make the necessary calculations. From the analysis of the data on soil losses through washing it is observed that they are in close connection with the degree of erosion. By comparing these data to the result we obtained: not eroded soil - 92 cm; poorly eroded soil - 76 cm; moderately eroded soil - 47 cm; strongly eroded soil - 40 cm; mollic delluvial soil - 132 cm; typical delluvial soil - 193 cm.

Key words*: agricultural land, irreversible loss of soil, humifer profile, statistical analysis, sustainable use.*

INTRODUCTION

Soil is an essential resource for all cultivated plants, being not only a support for plant roots, but also a reservoir of essential nutrients necessary for plant growth. Due to the widespread practice of intensive farming, the soil is threatened by a number of status factors such as erosion, loss of nutrient reserve, pollution, aridization, decreased fertility etc. Sustainable development means first and foremost to ensure a better quality of life for people, both now and for future generations. Sustainable development also means recognizing that the economy, the environment and social well-being are interdependent, especially in the conditions of an environment that is always under enormous anthropogenic pressure. All this requires a robust, healthy local economy able to create the means to meet these food needs for as long as possible (Blaga et al., 2005; Cerbari, 2010; Mureleanu et al., 1992).

Agriculture at the orchard stage of the development of human society implied a permanent competition between the ecological and the economic component. For these reasons, with the introduction of soil cultivation and sowing, agriculture could already be defined as a planned, economical, energy consumer system to increase productivity at the surface unit (Blum et al., 1994; Neamțu, 1996).

The largest areas of land damaged by landslides are in the districts: Calarasi - 3084 ha, Ungheni - 2094, Hancesti - 1364 ha, Straseni - 1115 ha, Telenesti - 1176 ha (Ghid practic, MDT-ACSA, 2015).

Agriculture has a major contribution to the sustainable development of the economy and society through the economic and social opportunities it confers on current and future generations. Agriculture is not just the support for biomass production, or the sector that provides food for humanity, but it is the very basis of life's existence. At the same time, however, agriculture must also take responsibility for protecting the soil and other environmental resources that it can degrade. Without a doubt, the production of food depends on many factors, but the quality of the land and, implicitly, the soil are decisive (Blaga et al., 2005; Cerbari, 2010; Montgomery, 2007; Neamțu, 1999; Rusu et al., 2009).

MATERIALS AND METHODS

Agricultural land of any kind, irrespective of its destination, the titles on the basis of which it is owned or the public or private domain, to which it belongs, constitutes the land fund of the Republic of Moldova.

According to the pedogeographical district of the territory of Moldova, elaborated by A. Ursu, the research object in the rural area, chosen to study the loss of fertile soil in the hilly area of the Middle Prut, is located in 13a district with ordinary and the dustycarbonate chernozems (Ursu et al., 1986; Ursu, 2011; Șișov et al., 2004).

The soils in the area from the left side of the Prut river, according to the results of our experiments (Cerbari, 2010; Cerbari et al., 2010; Cojocaru, 2015; Ursu, 2011) and other researchers (Mureleanu et al., 1992; Vilain, 2003; Rusu et al., 2009; Ursu et al., 1986; Dokuceaev, 1949) are characterized by a favorable loam-clayed or silty (rarely) dusty-sandy.

Thus, the clay powders are vulnerable to crust formation and erosion. Coarse sandy clay and, in particular, coarse sandy-clay are very vulnerable to compaction, having also under natural conditions high values of apparent density and of the degree of compaction and low values of total porosity, in agreement therewith, have lower water retention capacity of the plants and lower permeability, poor aeration and less favorable mechanical properties, especially cohesion and high shear resistance, especially at low humidity.

Potential erosion of soils located on different segments of the slope in the rural area of the Negrea commune was determined under standard conditions on 3 m^2 leakage control plots (Cojocaru, 2015).

RESULTS AND DISCUSSIONS

It is necessary to emphasize that any eroded soil is a result of a balance between the permanent process of pedogenesis and the process of its physical deterioration through erosion (Cerbari et al., 2010; Arinușkina, 1970).

In the case of inactive land (fallow ground) the denudation processes (natural or geological erosion) are slow (Constantin, 2011; Moțoc, 1963; Neamțu, 1999; Ursu et al., 1986) and soils of varying degrees of evolution are formed.

Soil erosion (accelerated erosion) is related to the influence of the anthropic factor on the land fund and has now become the main process of deterioration, degradation and desertification of agricultural land (Arinușkina, 1970; Blum et al., 1994; Cerbari, 2010; Montgomery, 2007; Moțoc, 1963).

The assessment of the state of degradation of agricultural land due to water erosion was carried out in Romania first by Moţoc M., Luca Al. and others (Constantin, 2011; Montgomery, 2007; Mureleanu, 1992; Neamțu, 1999) and in Moldova and other countries the study of eroded soils and the development of anti-erosion technologies was carried out by Zaslavski M.N. and others (Ursu, 2011; Dokuceaev, 1949; Konstantinov, 1987; Voloșiuk, 1978; Zaslavskii, 1966; Șișov et al., 2004).

Field measurements of penetration resistance of layers and horizons of ordinary chernozems at moisture close to field capacity showed low levels for the recently arable layer and comparatively large for the underlying posture layers, which increase the vulnerability of soils to erosion.

Determination of the washed soil mass on the slopes was performed on the basis of the average statistical data and the necessary calculations (Tables 1-6).

By comparing the average statistical thickness of the humifer soil profile of the not eroded soil with the appropriate thickness of eroded soils it was established decreasing thickness humifer profile eroded soils and increase its delluvial soils. The thickness of the loose soil layer for soils with different degrees of erosion is as follows:

poorly eroded - 16 cm; moderately eroded - 45 cm; strongly eroded - 52 cm (Cojocaru, 2015).

Table 1. The average statistical parameters of the humus content of *ordinary not eroded chernozems* in rural areas (Cojocaru, 2015)

Genetic horizon and average depth, cm	X	s	V, %	m	P, %	n
Humus content, %						
Ahp: 0-26	3.31	0.31	9.4	0.16	4.8	4
A+Bhp: 26-38	2.84	0.30	10.6	0.16	5.6	4
Ahbkp: 38-59	3.23	0.14	4.3	0.07	2.2	4
Bhk1: 59-72	2.02	0.17	8.4	0.09	4.5	4
Bhk2: 72-92	1.43	0.03	2.1	0.02	1.4	4
BCk1: 92- 111	0.72	0.20	27.9	0.10	13.9	4
BCk2: 111-130	0.57	0.09	15.8	0.05	8.8	3
Ck: > 130	0.41	0.04	9.8	0.02	4.9	3

Table 2. The average statistical parameters of the humus content of *ordinary poorly eroded chernozems* in rural areas (Cojocaru, 2015)

Genetic horizon and average depth, cm	X	s	V, %	m	P, %	n
Humus content, %						
Ahkp: 0-19	2.93	0.25	8.5	0.11	3.8	5
(A+B)hkp: 19-34	2.47	0.32	12.9	0.14	5.7	5
Ahbkp: 34-55	2.90	0.46	15.9	0.21	7.2	5
Bhk2: 55-76	1.44	0.27	18.8	0.12	8.3	5
BCk1: 76-101	0.73	0.23	31.5	0.10	13.7	5
BCk2: 101- 127	0.52	0.14	26.9	0.07	13.5	4
Ck: > 127	1.61	0.07	17.5	0.04	10.0	4

Table 3. The average statistical parameters of the humus content of *ordinary moderately eroded chernozems* in rural areas (Cojocaru, 2015)

Genetic horizon and average depth, cm	X	s	V, %	m	P, %	n
Humus content, %						
Abhkp: 0-24	2.31	0.35	15.2	0.14	6.1	6
Abbhk: 24-47	2.41	0.30	12.5	0.12	5.2	6
BCk1: 47-68	0.84	0.17	20.2	0.07	8.3	6
BCk2: 68-92	0.70	0.12	17.1	0.05	7.1	5
Ck: > 92	0.30	0.10	33.3	0.06	20.0	3

Table 4. The average statistical parameters of the humus content of *ordinary strongly eroded chernozems* in rural areas (Cojocaru, 2015)

Genetic horizon and average depth, cm	X	s	V, %	m	P, %	n
Humus content, %						
Bhkp: 0-22	1.74	0.41	23.6	0.14	8.1	9
Bbhk: 22-40	1.77	0.41	23.2	0.14	7.9	9
BCk1: 40-56	0.81	0.13	16.1	0.04	4.9	9
BCk2: 56-80	0.64	0.03	4.7	0.02	3.1	3
Ck: > 80	0.32	0.05	15.6	0.03	9.7	3

Table 5. The average statistical parameters of the humus content of *mollic delluvial soils (izohumic cumulative)* in rural areas (Cojocaru, 2015)

Genetic horizon and average depth, cm	X	s	V, %	m	P, %	n
Humus content, %						
Ahp1: 0-26	2.89	0.12	4.2	0.07	2.4	3
Abh1: 26-62	3.08	0.12	3.9	0.07	2.3	3
Bh1: 62-90	2.27	0.10	4.4	0.06	2.6	3
Bh2k: 90-132	1.38	0.13	9.4	0.08	5.8	3
BCk: > 132	0.96	0.27	28.1	0.16	16,7	3

Table 6. The average statistical parameters of the humus content of *typical delluvial soils (typical cumulative)* in rural areas (Cojocaru, 2015)

Genetic horizon and average depth, cm	X	s	V, %	m	P, %	n
Humus content, %						
I hkp: 0-23	2.45	0.2	8.2	0.1	4.1	3
II hkp: 23-46	2.29	0.1	4.4	0.1	2.6	3
III hkp: 46-69	2.45	0.5	20.4	0.3	12.2	3
Ahbk: 69-117	3.33	0.2	6.0	0.1	3.0	3
Bhk1: 117-148	2.23	0.5	22.4	0.3	13.5	3
Bhk2: 148-193	1.41	0.2	14.2	0.1	7.1	3
BCk: 193-213	0.89	0.1	11.2	0.1	6.7	3

Using the average apparent density and surface data of each eroded soil category, the following fertile losses were established for each soil unit on the slopes studied in the rural area:

a) *poorly eroded*: 183744 t or 1920 t/ha;
b) *moderately eroded*: 641520 t or 5400 t/ha;
c) *strongly eroded*: 475 904 t or 6760 t/ha.

Total were washed from the investigated slopes from the village of Negrea - about 1.3 million tons of fertile soil.

At the same time in the evaluated and researched area, to the formation of delluvial soils was retained following amount of fertile soil washed from the slopes:

d) *mollic delluvial soils*: 57 600 t or 4800 t/ha;
e) *typical delluvial soils*: 132 613 t or 13130 t/ha.

Total formation delluvial soils in the village Negrea about 0.2 million tons of pedolite was retained.

The irreversible losses of humic soil at the moment are extremely high, making up about 1.1 million tonnes of fertile soil.

These losses were calculated as the difference between the total amount of washed soil and the amount deposited in the depressions of the Negrea receiving basin, forming delluvial soils. The total area of the erosion-affected land in the studied area is 284.9 ha or 83.1% of the total area.

It appears that on each hectare affected by erosion on average, irreversibly historical about 3.9 thousand t/ha of humic soil was lost.

Delluvial soils, due to its location on the specific relief elements (depressions, valleys) partially diminish the negative effects of erosion processes and increases the stability of landfills.

It is worth mentioning that in the hilly area of the Middle Prut the valleys are narrow, their surface is small, delluvial soils are not widespread and their land stabilization effect is not high.

Mollic delluvial soils *(izohumic cumulative)* are much more fertile than eroded soils, but increased erosion on the slopes after deforestation of multiannual plantations leads to their intensive clumping with low humid pedolithic deposits and to the accelerated diminishing of their agricultural production capacity.

The large historical irreversible losses of washed material on the slopes, the small stabilizing effect of landscapes by the sloping soils, the high vulnerability of soils to conditioned denudation processes, first of all, the peculiarities of their texture place erosion as a degradation factor and deterioration of the soil cover in the hilly area of the Middle Prut.

This particularity of the territory must be taken into account in the re-planning of the lands of the pedological district 13a, and in the design and implementation of the necessary measures to combat the erosion processes (Cerbari, 2010; Cojocaru, 2015; Ursu, 2011).

Conservation and maintenance of natural soil fertility has been and is being supported and promoted by researchers and specialists, taking into account the current requirements for the development of sustainable agriculture.

Sustainable agriculture must be economically viable, „healthy" environmentally and socially fair (Blaga et al., 2005; Vilain, 2003; Rusu et al., 2009).

CONCLUSIONS

At the basis of the erosion control activities, should be made mandatory „ecologic limit of the territory" that characterizes the limit of self-generation of the environment.

When re-planning the use of the agricultural land fund of the reception basins in the hill area of the Middle Prut, it is recommended that these lands be used predominantly under the vineyard plantations.

A total of 1.3 million tonnes of fertile soil were washed from the slopes of the Negrea reception basin.

In total, the formation of the delluvial soils on the territory of the Negrea about 0.2 million t of pedolite was retained.

The irreversible losses of humic soil at the moment are extremely high, making up about 1.1 million tonnes of fertile soil.

The large historical irreversible losses of washed material on the slopes, the small stabilizing effect of landscapes by the sloping soils, the high vulnerability of soils to conditioned denudation processes, first of all, the peculiarities of their texture place erosion on the forefront as a degradation factor and deterioration of the soil cover in the hilly area of the Middle Prut.

Therefore, a number of measures are needed to improve the existing serious problems, welcome by both the government and the local authorities and communities.

Agriculture at the orchard stage of the development of human society implied a permanent competition between the ecological and the economic component.

For these reasons, with the introduction of soil cultivation and sowing, agriculture could already be defined as a planned, economical, energy consumer system to increase productivity at the surface unit.

Consequently, there must be a major interest in innovative technologies, sustainable land use systems that prevent or minimize soil degradation, restore productive capacity and the vital processes of degraded soils.

According to the results of the evaluation and examination of the quality of ordinary chernozems in the rural area of Negrea, the finding of the situation in the field of sustainable use of local agricultural land is deplorable.

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BIOMASS NUTRIENT CONCENTRATION AND UPTAKE OF GRAFTED AND NON-GRAFTED PEPPER PLANTS

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Abstract

Study was conducted to compare nutrient concentrations and nutrient uptakes of grafted and non-grafted pepper. The F1 hybrid, long type 'Efil' (Asgen, Turkey) was grafted on commercial rootstocks, 'Guclu' (GrainesVoltz, Türkiye). Un-grafted 'Efil'cultivar and itself grafting 'Efil/Efil' were also used as control. The experiment was conducted until the harvest. Plants were fertigated during the growth periods containing Hoagland nutrient solution. After the harvest, ten plants were cut above ground the soil randomly. Each plant was cleaned, dried, weighted and analyzed for mineral element. Results showed that plant dry weight did not vary depending on the grafting. Plant P and Ca concentrations obtained from the grafted and non-grafted peppers significantly varied each other; however, other nutrient concentrations did not vary significantly. Although, plants P, Ca and Cu uptakes showed variation between grafted and non-grafted peppers, other nutrient uptakes were not affected from the grafting.

Key words: *grafting, growth, tomato, nutrient concentration.*

INTRODUCTION

In order to meet increasing food demands of growing population in the world, some attempts are being provided in horticulture as in other agricultural production systems. Decreasing of fertile agricultural soils, non-favorable soil, environmental and climatic conditions, increasing costs of agricultural inputs, etc. force the agriculturists to develop new ways. Vegetable grafting is one of the ways to obtain high quality fruit yield. Although, basic reason of grafting was to prevent the plants from soil pathogens in the past (Lee, 1994), some other benefits were realized over the years. While, some researchers used the grafts to increase resistances against low and high temperatures (Rivero et al., 2003; Venema et al., 2008), some researchers used to increase plant nutrient uptake (Ruiz et al., 1997a; Colla et al., 2008), synthesis of endogenous hormones (Dong et al., 2008). Rouphael et al. (2008) indicated the improvement in efficient water use in grafted plants. Also, plants become resistant to soil pollutants (Otani and Seike, 2006), some element toxicity (Edelstein et al., 2005; Rouphael et al., 2008; Arao et al., 2008) and salt and flooding injury with grafting (Fernández-García et al., 2004; Martinez-Rodriguez et al., 2008).

There are some different reports conducted on the examinethe effectiveness of rootstock and scion effects on mineral nutrient concentrations of a variety. According to the findings of some researchers indicates that rootstock and scion has an important role on foliar nutrient concentrations and nutrient uptakes of fruits (Poling and Oberly,1979; Tagliavini et al., 1992; Kucukyumuk and Erdal, 2009; Kucukyumuk and Erdal, 2011). Results of the Ruiz et al. (1997b) show that there was a little changes in leaf nutrient concentrations between different rootstocks. They also indicated the strong relationship between the variations in foliar concentrations of N and Na and yield differences in grafted plants. According to the results of Khah et al. (2006), fruit Ca concentration in grafted tomato was greater than in the fruits of un-grafted tomato cv. Similarly, Tsouvaltzis et al. (2004) indicated that fruit mineral concentration increased, when tomato cv. was grafted. Rouphael et al. (2008) showed that grafted watermelon plants had similar fruit P and Ca concentrations, where as K and Mg concentrations were significantly improved by both irrigation rate and grafting combination. But there are also many studies indicating the ineffectiveness of grafting. Chaplin and Westwood (1980), working with grafted fruit trees, found no evidence that the different rootstocks used caused variability in leaf nutrients. Proietti et al. (2008) reported no difference in the nitrate concentrations between grafted and un-grafted watermelon pulps. Similarly, Colla et al. (2010) indicated that the nitrate concentration of melon fruits did not vary with grafting. Fernandez- García et al. (2004) were detected no significant differences in nitrate concentration of tomato fruits in both grafted and un-grafted plants.

The aim of the present work was to investigate the differences of biomass nutrient concentrations and nutrient uptakes between grafted and non-grafted pepper plants under field conditions feed by nutrient solution.

MATERIALS AND METHODS

The F1 hybrid, long type 'Efil' (Asgen, Turkey) was grafted on commercial rootstocks, 'Guclu' (GrainesVoltz, Türkiye). Un-grafted 'Efil' cultivar and itself grafting 'Efil/Efil' were also used as control. The cleft grafting was realized when rootstocks and grafts showed six and two true leaves, respectively. Grafted and un-grafted pepper plants were transplanted on 05 April 2016 in open field condition on the Experimental Farm of Suleyman Demirel University.

Study was planned according to the randomized parcels with 10 replicates under field condition and plants were fertigated with Hoagland solution during the growth period. At the end of the harvest, plants were pulled up from the soil and bought the laboratory.

Then, plants were cleaned with top water; roots were omitted and above ground biomass were washed with dilute acid and pure water to remove surface residuals. After, plants were dried at 70°C until the stable weight was reached.

Finally, dried plant materials were weighted, grounded and wet digested with microwave oven for nutrient analysis. Phosphorus concentrations of samples were determined with a spectrophotometer (Shimadzu UV-1208) at 430 nm according to the vanadomolybdo phosphoric acid method.

Potassium, Ca, Mg, Fe, Cu, Zn, and Mn concentrations were determined using atomic absorption spectrophotometer (Varian AA240 FS).

The experimental soil was loamy (Bouyoucos, 1951) having pH 7.9 (1: 2.5 soil to water ratio), 9.5% $CaCO_3$, 1.1% organic matter (Jackson, 1962), 15.9 mg kg^{-1} NaHCO3 extractable P (Olsen et al., 1954), 125, 266, 375 mg kg^{-1} 1N NH_4OAC exchangeable K and Ca and Mg (Knudsen et al., 1982). DTPA extractable Fe, Cu, Zn and Mn concentrations (Lindsay and Norwell, 1978) were 2.9, 0.55, 0.89 and 11.9 mg kg^{-1}, respectively.

All data were submitted for statistical analyses using MSTAT program for one-way analysis of variance applied to determine any significant difference at 0.05%.

RESULTS AND DISCUSSIONS

Dry weight

Plant dry weights and nutrient concentrations

Plant dry weight varied between 43.7 g and 49.8 g but these variations did not make any statistical sense. Plant nutrient variations were between 0.12%-0.14% for P, 3.58%-3.72% for K and 0.51%-0.55% for Mg.

As could be seen from these values, there were small differences between grafted and non-grafted peppers but, these differences also were not significant. Only Ca concentrations showed significant differences and the highest Ca was determined with the grafting of cv. 'Efil' on its own rootstock. Grafting of cv. 'Guclu' on the rootstock-'Efil', gave the lowest Ca amount. There was not significant variation between grafted and non-grafted 'Efil' varieties as well (Table 1).

Biomass micronutrient concentrations were given in Table 2. As could be seen from there, only Cu concentrations were significantly affected from the grafting.

While non-grafted 'Efil' cultivar has the highest Cu value (9.8 mg kg^{-1}), other grafted materials have lower Cu value and they took place in the same statistical group.

Table 1. Dry weight and macro nutrient concentrations of grafted and non-grafted pepper plants

Variety	DWg	Nutrient concentrations, %			
		P	K	Ca	Mg
Efil	49.8	0.12	3.72	0.37 AB*	0.51
Efil/Efil	45.5	0.13	3.68	0.41 A	0.55
Efil/Guclu	43.7	0.14	3.58	0.33 B	0.51

*shows the differences between grafted and non-grafted plants(P<0.05); there is not a significant differences between the values shearing the same letters.

Table 2. Micro nutrient concentrations of grafted and non-grafted pepper plants

Variety	Nutrient concentrations, mg kg^{-1}			
	Fe	Zn	Mn	Cu
Efil	194	184	149	9.8 A*
Efil/Efil	206	180	144	8.5 B
Efil/Guclu	215	177	154	8.0 B

*shows the differences between grafted and non-grafted plants (P<0.05); there is not a significant differences between the values shearing the same letters.

Biomass nutrient uptake

Plant nutrient removal by above ground biomass of pepper plants was given in Table 3. As could be seen from there, most of the nutrients removed by upper part of plant such as P, K, Mg, Fe, Zn and Mn, did not vary with grafting. Only, Ca and Cu removal of pepper plants by above ground biomass changed with grafted and non-grafted plants.

Looking at the results it can be said that there were not significant differences betweeen grafted and non-grafted 'Efil' pepper cultivar in terms of growth, most nutrient concentrations and uptakes. These results might seem not to be in the accordance with the most studies conducted on rootstock and scion. But there might be several reasons of this. The first reason in this study might be the fertilization type. As indicated before, plants were fed with the nutrient solution during the growth period. So, plants received nutrients easily from the media without needing rootstock or scion root's performance. The other reason of these results may be due to the similarities in the root systems between rootstocks (Ioannou et al., 2002; Kacjan-Marsic and Osvald, 2004). As known, root system of the plants affects vegetative growth, yield, water and nutrient uptakes. Some of the researchers explain the importance of harmony between the rootstock and scion on vegetables growth and nutrition (Leonardi and Giuffrida, 2006). As mentioned by Romano and Paratore (2001), vegetable grafting does not improve the yield when the selection of the rootstock is not suitable.

CONCLUSIONS

As conclusion, there were no differences between grafted and non-grafted pepper variety used in this study in terms of plant growth, nutrient concentration and nutrient uptake.

Table 3. Nutrient uptake of grafted and non-grafted pepper

Variety	Nutrient uptake							
	g $plant^{-1}$				mg $plant^{-1}$			
	P	K	Ca	Mg	Fe	Zn	Mn	Cu
Efil	0.060	1.85	0.18 AB*	0.25	9.66	9.16	74	0.49 A
Efil/Efil	0.059	1.67	0.19 A	0.25	9.37	8.19	66	0.39 B
Efil/Guclu	0.061	1.56	0.14 B	0.22	9.40	7.73	67	0.35 B

*shows the differences between grafted and non-grafted plants (P<0.05); there is not a significant differences between the values shearing the same letters.

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THE CONTENT AND TENDENCY OF ANTHROPOGENIC EVOLUTION OF SOIL COVER

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Abstract

Soils which were arable for a long time are typical polygenetic formations as the anthropogenic factors played the significant role in their formation alongside with natural ones. Under mechanical, chemical and ameliorative actions the natural soils lose a structure inherent in them, properties and modes. Amplifying anisotropy, spatial heterogeneity, preferential descending and ascending streams of a moisture, formed new types of horizontal and vertical soil profiles, the equilibrium density, ability to convertibility of properties and modes as the basic condition of counteraction to degradation processes is lost. Significant changes occur in thin dispersive mineral and organic parts. As a result of anthropogenous evolution for rather short historical time interval it is formed the new body - antropogenic transformed soil - agrozem which becomes a 4-dimensional body of the nature as its parameters are changed in space and time. This fact demands reflection in soil classification and corrective amendments in studying, management of their fertility and use. Possible scripts of the further anthropogenic evolution of soils are discussed: the degradation, balance and "smart" out-degradation transformation.

Key words: *agrozem, degradation, evolution, fertility, soil.*

INTRODUCTION

Anthropogenic factor is one of the soil-forming factors, but still it's not found its place among other factors. This fact is recognized in a number of classifications of foreign countries (e.g. Russia, Belarus) and anthropogenically transformed soils or agrozems appeared. Similar proposals exist in the Ukraine (Tikhonenko, 2010). However, in the current soil classification of Ukraine (Izdatelstvo 'Kolos', 1977) and some attempts to improve it (Polupan et al., 2005), it is only possibility to correct the main process for long-used soil at the level of variant without changing the natural basic orientation of soil formation. According to Grinchenko et al. (1965), the process of soil amelioration is considered as an opportunity to preserve and improve the important agronomically properties of soils under conditions of long-term rational use with the invariability of the basic type of natural soil formation. Since the 60-ies of the XX century we conducted comparative research of predominantly chernozem soils under different conditions of use, from absolutely conservation virgin soil to variants where various agro-practices were applied. A significant amount of information was accumulated during the research of the basic properties and regimes of soils. An attempt to formulate regularities of anthropogenic transformation of arable soils, that were in conditions of long unbalanced and poor-quality use and to substantiate improved approaches to the research of old-arable soils for the purpose of their scientific monitoring were made in the article.

MATERIALS AND METHODS

The objects of research are arable soils of Ukraine. The analytical and field methods of soil research are classic methods adopted by Ukrainian standards (List of basic normative documents, 2017). Field methods include field research with situational maps, the field being divided into analytical units or parcels, the profiles are placed from which soil samples are collected in dependence on the pedological complexity, the mode of land use and the research purpose. The analytical methods are laboratory standard analysis of soil samples for selected indicators. Continuing the analysis and validation process of the results obtained by classical methods of soil analysis and carried out in the field takes place by completing with data obtained through GIS. Mathematical and geostatistical methods have been used for land quality using generalized covariance functions. Applied geostatistics techniques included Aerial Surveillance with Remotely Controlled Aircraft (DPLA).

RESULTS AND DISCUSSIONS

Factors of anthropogenic evolution. The main factors of anthropogenic evolution are mechanical, chemical, ameliorative impact on the soil cover, disturbance of the natural balance of substances and energy, weakening of soil cover stability through to excessive plowing and deficiency of forests and grassland, development of urbanization, industrial zones, etc. Natural soils changes their structure, properties and regimes and gradually transformed into new bodies of natural-anthropogenic (polygenetic) origin under the influence of the above factors.

Argillisation of soils - the initial stage of transformation of soils under the action of tillage. Krupenikov (1978) was first one, who paid attention to the manifestation of argillisation in chernozems (genetically undifferentiated soils) under the influence of prolonged agricultural use, later - Garifullin (1979), Korolev (2008). In our research (Medvedev, 1988), this process was also confirmed: according to the results of the granulometric analysis, it was difficult to prove an increase in the content of clay in a long-plowing arable land in comparison with an absolutely conservation virgin soil. However, if we determine the specific soil surface by sorption of water molecules from vapor with an elasticity of 0.2 (according to Kutilek), the total active surface (by sorption of water from vapors with an elasticity of 0.35 to 0.98 in accordance with the Obermiller range) and ultraporosity (by sorption of benzene molecules - a nonpolar liquid - with the elasticity of its vapor from 0.23 to 0.8 kPa) it is possible to obtain evidence of a change in the quality of the soil surface after a long tillage. These liquids reflect well enough even small changes in the state of the soil surface. Herewith, the most adequate representation of the magnitude of the soil surface can be obtained from sorption of moisture (Voronin, 1959), from the sorption of benzene - its ultraporosity (Antipov-Karataev et al., 1948), and by comparing these data - the hydro-philicity and hydro-phobicity of soils as sorbents (elasticity or rigidity of their structure). According to Medvedev (1988), chernozems are predominantly sorbents of a non-rigid elastic structure.

New horizontal and vertical profiles of anthropogenic soils. Because of the peculiarities of the technology of growing crops, turning and loading-unloading of vehicles, sewing machine, fertilizers and combines at the margins of the fields, soils are constantly subjected to a stronger influence of running systems of machine-tractor units (MTU). As a result is soil re-compaction, the reversibility and ability to restore modal parameters are gradually lost. These processes intensify the spatial variegation of the field. The coefficient of horizontal spatial diversification of the content of available phosphorus on the arable land in Forest-steppe amounts 0.56, while on the same virgin land it is only 0.09. According to our observations, more strengthened and deeper furrow bottom with a hardness of more than 30 kgf/cm^2 is formed precisely at the margins of the fields, which significantly limits the growth of roots in depth and reduces the adaptation of plants to a moisture lack. As a result, almost field variegation is marked on arable land (Medvedev et al., 2015).

In the lower parts of the field, where the level of moistening is higher, there is a similar re-compaction effect of MTU on the soil. Differences in the value of the equilibrium density of addition and hardness in different parts of the field are significant. Over a 30 years observation period, it was noted a significant increase in the thickness of furrow bottom from 30-40 cm to a depth of 70 cm. Thus, new horizontal and vertical profiles are gradually formed on old-plowed soil, and spatial heterogenization of soils increases eventually (Medvedev, 2011, 2012).

Physical degradation of soils is considered as a process that leads to soil re-compaction, loss of structure, its quality, the formation of lumps in the surface layer, crusts and cracks, and at the base of the plowed layer - the furrow bottom. Diagnostic indicators of degradation are: simplification of structure and pore space morphology, steady increase in the equilibrium density, decrease in inter- and especially intra-aggregate porosity, formation of preferential moisture flows that are uncharacteristic for natural soils. The main cause of physical degradation is the exceeding of the level of mechanical loading of the soil's ability to restore the modal parameters of the structure, properties and regimes.

The lumpiness of old-arable soil becomes almost an obligatory characteristic unlike virgin land, where lumps are absent. In a lumpiness arable land it is impossible to create a sufficient supply of available moisture: it either falls into the lower layers of the soil profile, or evaporates. Also, it is impossible to implement high quality sowing of field crops. Seedlings of plants turn out to be in homogeneous, and their development is uneven. For the destruction of lumps, additional tillage and investment of costs are necessary. Research by Bakhtin (1969) found that even a minor deviation of moisture at the time of tillage from the humidity of soil physical maturity leads to the formation of lumps. In this regard, more than 82% of the arable soils in Ukraine form lumps, and about 12% - to a large extent (Medvedev, 2008). These are alkaline soils of dry Steppe, Vinnytsia is land of eroded graypodzolized soils, gleyed soils of Precarpathian and Transcarpathian, and also throughout many regions of the Forest-Steppe and Steppe. This phenomenon is typical for almost all soils, except for sandy and loamy sand type. In the Steppe of Ukraine, where the residence time of the soil in the state of physical maturity is very short, the probability of formation of lumps during tillage is significantly increased.

The density of loamy chernozem soil on virgin soil is approximately 1.0-1.1 g/cm^3, the same arable chernozem - in the range from 0.8-0.9g/cm^3 immediately after tillage to 1.15-1.35 g/cm^3 in the equilibrium condition. The period of equilibration (relaxation), depending on the agrofond and precipitation, lasts from a few days to two weeks. During this period, the dynamics of water-air and biological properties of soil are noted, depending on the density of soil. Due to low density and humidity, close to physical maturity, in the spring there is a real threat of compaction of all soils without exception, which is in chernozems.

If the chernozem typical and chernozem ordinary of medium-loamy granulometric composition are plowing in a state of physical maturity, the content of agronomically valuable aggregates (particles 10.00-0.25 mm in size) is 60-80%. Herewith, even a slight compaction or a deviation from the moisture of physical maturity significantly impairs the tillage soil quality.

The water-stability of macro-aggregates of chernozems on the virgin soil, as a rule, reaches 70-80%, and in arable soils - no more than 50%, which is a consequence of the loss of organic matter with constant loosening of the soil and the dominance of aerobic microorganisms. Reduction of water-stability and aggregation potential on arable soils in comparison with virgin soil testifies to the existence of processes of physical degradation in old-arable chernozems (Medvedev, 2008).

Preferential flows of moisture (or extensive filtration over large pores) are formed in arable soils due to the presence of lumpy particles in it. Comparative research of the filtration capacity of different structural fractions indicates that for instantaneous downward traffic of moisture, a small amount of lumpy particles and large pores are needed. In the arable layer, preferential flows are formed by lumpy particles, in the depth of the profile – due to large pores of biological genesis (Medvedev et al., 2003).

The research confirms the multiple increasing filtration, as soon as only a small number of lumps appears in the soil (Vershinin, 1959).

Quite reasonably the ascending flow of moisture can be attributed to preferential, which leads to unproductive losses of productive moisture as a result of physical evaporation processes due to the presence, of lumps in the surface layer (Medvedev et al., 2004; Medvedev, 2008).

Chemical degradation of soils. The content of total humus in the arable layer of almost all soils according to different data is 20-50% lower than in their virgin analogues (Medvedev, 2012). Losses of humus are characteristic for unbalanced land use. The deficiency balance of organic matter actually lasts on arable soils from the moment of their development. As a result the soil is degraded and this is a universally recognized fact. The characteristic lane of the increased content of humus in chernozems which forms an axis from the southwest to the northeast (Odessa, Kirovograd, Poltava and Kharkov regions) was disappeared. It's well known the northern boundary of this lane coincides with the barometric maximum which divides the territory of Ukraine into two parts: north-western (moistened and cooler) and south-eastern (warmer and arid). According to the Institute of Soil Protection of Ukraine, the annual loss of humus in the period 1965-1990 reached 1, now - about 0.5 t/ha per year. Old-arable chernozem is destructed, its anti-erosion resistance is reduced due to a decrease in the amount of organic matter and its labialization in comparison with natural chernozem (Figure1).

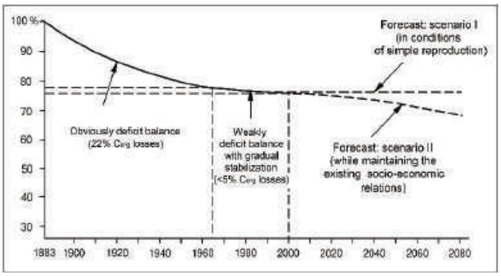

Figure 1. Dynamics of humus content in chernozem soils and forecast of its changes

Reversibility of soils is an important soil property, meaning its ability to restore its modal (most likely for these local conditions) parameters after removing the mechanical or chemical load. There is many reason to believe that the long-plowed soil has lost its reversibility, because the new parameters have become stable. Such soil has acquired a different morphological profile, other properties and regimes. If plowed soil will be taken out from arable land for a sufficiently long period, its properties can be restored (Medvedev, 2008). Soil observations conducted in Argentina and Brazil under conditions of zero tillage are evidence of this (Medvedev, 2010). Active erosion manifestations and other signs of degradation are practically absent in such soil. In this regard, the removal of old-plowed soils from arable land that have acquired signs of degradation and lost economic value is an important task.

The structure formation is markedly inhibited and its quality is further significantly reduced as a result of long tillage. We proposed soil aggregation norms showing the amount of aggregates of agronomically useful size and their water-stability, which account for 10% of the physical clay (Medvedev, 2008), which differ significantly on the virgin land and plowland. So, for example, for typical and ordinary chernozems loamy granulometric composition, they are 1.75 and 1.60 for structural aggregates with sizes from 10.00 to 0.25 mm and 1.60 and 1.00 for water-stability aggregates larger than 0.25 mm.

Scenarios for further anthropogenic soils evolution:

- degradation is the most likely scenario while preserving modern unbalanced and inequality agriculture. Degradation in these conditions can gradually become a factor that forms an agro-soil;
- seeming equilibrium is the most likely scenario because the evolution of soils cannot be balanced in conditions of a long deficit balance of biophilic elements and excessive mechanical stress;
- stability development is a scenario that should be pursued („smart, intelligence, agriculture");
- scenario for the near future is instead of zonal generalized technologies one should use precise agriculture with considering spatial variegation, field history and the stage of its anthropogenic evolution.

On the regeneration and „equilibrium" of soil fertility in modern agriculture

The first scientific conclusions about the degradation of soil properties under conditions of long plowing were made by the researchers of domestic and foreign pedology and agriculture even more than 100 years ago (Dokuchaev, 1892; Russell, 1955). They noted a sharp degradation in the physical properties of soils, the loss of organic matter, the intensification of erosion processes in arable soils compared with the virgin soil. Even then the system of farming was found to be unsuitable, requiring replacement. Now we began to calculate the balance of nutrients in the production environment relatively regularly, so we obtained data on changes of soil properties and regimes during the tillage, agrochemicals, irrigation and drainage. The statements of the classics were confirmed. Moreover, balance in the fertility of soils at this stage in the development of agriculture cannot be achieved.

According to generalized data (Medvedev, 2012), the most characteristic processes in soil changes over the past 40-50 years are:

- dehumification of plowed soils;
- increasing deficit of the balance of available nutrients, especially nitrogen and potassium (respectively 41.5-56.4 kg/ha in 2001, 32.9 and 64.2 kg/ha in 2009);
- acidification of chernozem soils (in some region of the forest-steppe zone);
- soil compaction of 40% of arable land (especially in the western Forest-steppe), destruction, lumpiness and crusting;
- reduction in the depth of the topsoil with erosion, which reaches several centimetres in chernozem soils and over dried soils of Polissya;
- secondary alkalinisation and salinization of irrigated soils.

The main cause of degradation is the underestimation of the real threat that forms this phenomenon for present and future generations, the lack of effective mechanisms for implementing laws on soil conservation, unbalanced and scientifically groundless land use. The problem was aggravated due to the termination (in fact, since 1991) of the state and regional land protection programs. Significant results were achieved until the end of the 1980s.

By main program parameters. In the following years, volumes of soil fertility improvement works have decreased to the minimum values: agroforest amelioration has not been carried out, volumes of fertilizer application have decreased, considerable areas of chernozem soils have not been tillage, and as a result, the content of nutrients has decreased, acidification of chernozems has occurred, and their physical properties have deteriorated.

Decrease of soil cover stability. The use of arable land with unfavorable properties is economically inefficient and creates a threat of further deterioration of soil properties due to the imbalance of modern agriculture. According to Dobrovolsky et al. (2002) about 30-40% of the territory must be supported in an virgin natural state. About the same amount of land can be plowed with an erosion-resistant agricultural landscape (Svetlichniy et al., 2004). According to Guidelines (1983), there should be a ratio of 1: 1 between the ecologically stable land (forest, pasture land, hayland, pond) and lands that destabilize the landscape (arable). It meets these recommendations of FAO in most countries of the world, with the exception of Hungary, Ukraine, some USA states and some countries of Southeast Asia.

Monitoring of the plowed soil. It is necessary to take into account new characteristics in monitoring - the dynamics of the main properties and regimes (moisture, air and other characteristics), relaxation as a period of balancing. New phenomena inherent in the plowed soil - drift and inertia (in English transcription [lag] or literally „retard”) or the time during which the soil restores its modal characteristics requires careful analysis.

There is no established opinion in the literature about the recovery time. According to Litvin et al. (1974), soil needs about 2 weeks with optimum temperature and humidity conditions to reach the maximum level of soil conditioning and to restore the bulk density of addition after tillage - from several days to 2 weeks, depending on agrofonds and precipitation (Medvedev et al., 2004). Based on the data of agrochemical certification of arable soils in Ukraine, it can be concluded that by 1990, in Ukraine, after 25 years of intensive chemicalization, a simple reproduction of fertility was achieved. The fall of humus has sharply slowed down in the soils and the inertial phase has come, Zubetz et al. (2007). In the central belt of the USA, where chernozem like soils (mollic soils) are prevailed, it took almost 60 years, since the losses of humus were 2 times more intense than in Ukraine (Lal et al., 1998).

Smagin (2012) confirmed that the degradation of chernozems does not end even after 200 years of their exploitation. He used the original method of reconstructing the dynamics of the development of chernozems. In subsequent years, it extends to deeper horizons, resulting in a gradual mineralization of more than 70% of the original humus stock. For the first 100-200 years it is lost from 30 to 50%, later the process continues more slowly. Only for 2-3 thousand years a new stationary state can be formed, which corresponds to a 3-4-fold decrease in the source of humus substances in comparison with the virgin land.

Thus, the soil has several mechanisms that allow resisting anthropogenic interference. This is a biological mechanism, that is, the ability to self-purification, and a physic-mechanical mechanism that reveals the essence of such processes of maintaining soil properties as buffering power, adsorption, barrier function. Due to the existence of these mechanisms, the soil is able to reduce the negative consequences of plowing. Any soil has a certain resistance, after exceeding which irreversibly degrades.

If the soil is able to restore characteristic parameters, it remains in an intermediate apparent equilibrium state. If the soil has lost its ability to return to its original state, then it has become degraded. And in this case, it is necessary to take appropriate measures: removing from the arable land or raising its fertility level. Monitoring of the arable land should provide for an appropriate set of tools to address these issues. Preference should be given to data obtained: *in situ* (directly in the field) and *on-line* (continuous registration of soil properties). Such regimes eliminate the need to select and transport soil and plant samples to the laboratory, making all preparatory operations and analytical work unnecessary. These regimes *in situ* and *on-line* will eliminate the inevitable discrepancy between field and laboratory measurements, taking into account the constant dynamics of the main soil regimes in time, depending on humidification, temperature, microbiological activity. It is difficult to describe correctly the peculiar rhythm of the soil formation processes inherent in the plowed soil, based on the results of traditional monitoring. Today, the opportunities for studying the real daily, seasonal, annual and long-term dynamics of soil processes are rapidly expanding.

To describe the processes of soil formation in arable land, it is important to conduct scientific monitoring, and obtain information of maximum accuracy and capacity, suitable for predictions and sound management decisions.

It is also necessary to establish soil-ecological polygons in order to study of following tasks:

- study of the spatial distribution of chemical elements, indicators of soil properties and processes, depending on the landscape situation and anthropogenic factors (the task of „geostatistics");
- observations of changes in main characteristics of soils under the influence of natural and anthropogenic factors (the task of „dynamics");
- study of quantitative and qualitative parameters of redistribution of chemical elements, surface and intrasoil run off (the task of „migration");
- carrying out experiments with artificially given parameters of anthropogenic load (the task of „modelling and forecasting").

To conduct research the land polygon is equipped with drainage and microstock sites, lysimeters, observation wells, precipitation gauges, gauging stations, detailed soil mapping is carried out.

It is ideal variant when the soil-ecological polygon is supplemented by long-term (stationary) field experiments to research different level sand types of anthropogenic load (with tillage, fertilizers, land melioration and others). Usually such experiments are conducted with the purpose of developing an optimal technology for obtaining crop production and observations of changes in soil parameters in them look like not mandatory application to crop yield data or ecological and economic interpretations.

Such observations can and should become an independent and extremely important assessment in a variety of ways:

- the definition of characteristic indicators of properties and processes at different levels of anthropogenic pressure (starting from the minimum, on the control, to the maximum, not having a place today, but expected in the future);
- determination of the rate of change of properties and processes under the same loads;
- the establishment of a general orientation of the change in indicators and processes (a quantitative description of the anthropogenic evolution of soils).

The implementation of projects of the scientific monitoring will allow using advantages of the pedotransfer modelling for forecasting of soil processes. The control of elementary soil-forming processes, productive and ecological functions, proactive information on the state of soils, migration of substances and contaminants to adjacent environments should become important tasks of scientific monitoring and at the same time a tool for the development of experimental soil science of increased information content.

In soil science and agrochemistry, there are many models that can reliably predict the behavior of soluble salts (accumulation or leaching), organic substances (mineralization or humification), moisture (diverse migrations), development of root systems, cycles of individual elements (C, N, P etc.), fertilizer efficiency, crop productivity. More complex, non-equilibrium models make it possible to predict the direction and parameters of the evolution of the soil cover to a distant future under the influence of global climate change.

The forecast is an extrapolation in time, the calculation of future values. This part of the soil science is especially in need of development due to the absence of a long series of equidistant observations, as an indispensable condition for the development of a correct „long-term" forecast. Methods of the forecasting should be developed with the development of the monitoring in the soil science, since the widespread ones (simplified regression models, models of exponential smoothing of Brown, moving averages etc.) turned out to be untenable. The methods of Boxing and Jenkins should get a preference, approbation of which gave positive results (Medvedev, 2012).

Methodology for managing the fertility of long - term plowing soil. Appropriate agrotechnology should be used on long-term plowing soil. If the parameters of the properties are in a favorable range of values, then the main thrust of agricultural technologies should be the use of such processing methods that would contribute to their preservation. As the properties of these soils deteriorate, the saturation with improving tillage should increase. If the soil is irreversibly worsened (the relevant criteria are known - Novakovsky et al., 2000), then it must be taken out of arable land. This is only a general scheme, in which it is necessary to introduce refinements depending on the real state of soils, genetic, climatic, orographic, lithological and many other features of the soil cover, as well as on the direction and intensity of its economic use.

Given the exceptional role of soils, especially chernozem, in creating economic and environmental well-being, it is necessary to have a clearly defined strategy for their protection This means effective functioning of soil protection programs and laws, strict monitoring of their implementation, monitoring using a broad program of indicators, mandatory rationing of all types of loads, observance of recommended and introduction of the newest soil protection technologies

The program for the development of the agro-industrial complex of Ukraine posed very ambitious tasks regarding agricultural products. We are sure that traditional approaches based only on fertilizers and intensive tillage cannot solve these problems. We need to learn how to regulate not only the nutritional regime, but also the moisture and air regimes, not to allow the root-inhabited layer to be re-compacted and, most importantly, to reduce the unproductive loss of moisture. It is here that the newest agricultural technologies could be useful - conservative, accurate, zero, other treatments that have a soil and economic effect.

CONCLUSIONS

As a result of anthropogenous evolution it is formed the new body - antropogeneous transformed soil, which, in comparison with the virgin lands has different structure, properties and regimes. Anisotropy, spatial heterogeneity, preferential descending and ascending streams of a moisture are amplified, new types of horizontal and vertical soil profiles are formed, the equilibrium density, consolidation and the amount of false aggregates are increased (grow), the structure of the pore space is changing, there is an obvious slowdown of aggregation processes, ability to convertibility of properties and modes as the basic condition of counteraction to degradation processes is lost. Significant changes occur in thin dispersive mineral and organic parts.

Agrosoils as soils with a structure, properties and regimes, that differ from natural, should receive an appropriate place in the classification, and their use and management of fertility must correspond to the degree of their transformation and the stage of anthropogenic evolution.

Possible scenarios of anthropogenic evolution of soils: degradation is the most probable - while preserving modern unbalanced and poor-quality agriculture, seeming balance is the least probable, likely it is the erroneous scenario resulting from short-term observations, sustainable development, as „reasonable" (smart) agriculture.

The organization of studies using in situ and on-line regimes, landscape soil-ecological polygons, complex stationary experiments using experimental planning methods, the use of effective methods for predicting soil processes is necessary for a favorable scenario of anthropogenic evolution of soils.

The purpose of modern agropedology is to justify the transition from zonal generalized technologies to precise agrotechnologies adapted to the characteristics of each field and the degree of their transformation.

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EVALUATION OF THE CELLULOLYTIC ACTIVITY DEPENDING ON SOIL TILLAGE SYSTEM AND METEOROLOGICAL CONDITIONS UNDER SUNFLOWER AGROCOENOSES

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Abstract

The aim of this work was to evaluate cellulolytic activity depending on soil tillage system, weather conditions in a long-term crop rotation under sunflower agrocoenoses. The study was carried out at the Didactic Station „Chetrosu" of the State Agrarian University of Moldova on carbonate chernozem with sandy loam texture. The cellulolytic activity was determined according to the Misustin (1978) method based on the principle of cellulose decomposition under aerobic conditions by incorporating linen tissue in the 0-30 cm soil layer. The researches has shown that soil cellulolytic activity under conservation tillage system - No-till is less with 15-20%, comparative with plowing variant during May-June period - characterized by sufficient rainfall and moderate temperatures. The July-August dry weather conditions have inhibited cellulolytic activity under conventional soil tillage from low to very low, being similar to the No-till variant, where cellulolytic activity also diminished with 10% from May-June to July-August period. The incorporation of linen tissues at different depths showed that cellulolytic activity is higher in the 20-30 cm layer and it is directly affected by the soil moisture.

***Key words**: carbonate chernozem, cellulolytic activity, soil moisture, soil tillage system, weather conditions.*

INTRODUCTION

Soil - a living organism made up of countless living microscopic creatures. The number and diversity of organisms that live in soil is immeasurable - over 20 groups of species, totalizing thousands of species in terms of population size especially bacteria, fungi and algae (Berca, 2008). These microorganisms have a special role in organic material transformation.

Bacteria are the most widespread group of microorganisms ranging from several hundreds to billions in each cm^3 of soil and represent 40% of the amount of microorganisms in the soil. The most populous area of bacteria is found in the nearness (2-5 mm) of plant roots, called the rhizosphere (Girla and Cazmalî, 2013), and according Alcamo (2003) one gram of soil in the rhizosphere contains about 500,000,000 microorganisms.

About the way of nutrition, the bacteria are classified into heterotrophs and autotrophs, and by the way of oxygen use in aerobic and anaerobic. Soil fungi are predominantly aerobic heterotrophic microorganisms that prefer an acid environment, live alongside bacteria and are of great importance in the humification and ammonification process.

Actinomycetes are a form of transition from bacteria to fungi, they develop under acid to alkaline pH, have a high capacity of decomposition of organic substances (Girla and Cazmalî, 2013).

The rate and extent of cellulose degradation by microorganisms and their enzymes is dependent in part on physical and chemical parameters such as temperature, pH, O_2 supply, availability of other sources of substrate. The study of relationship between soil tillage and residue management practices and enzyme activities is important, because enzyme activities potentially may be used as indexes of soil fertility, productivity, and soil tilth and quality.

Understanding the process of cellulose decomposition and identifying the factors involved in this process in soils would be an important building block in understanding the microbiological and biochemical changes associated with tillage and residue management practices (Deng, 1994).

MATERIALS AND METHODS

The study was carried out at the Didactic Station „Chetrosu" of the State Agrarian University of Moldova, located in the South-East side of the Central Moldavian Plateau on carbonate chernozem with sandy loam texture.

The cellulolytic activity was determined in a long-term crop rotation under sunflower agrocoenoses with conventional and No-till soil tillage systems, and at different weather conditions registered during two vegetation periods (May-June and July-August of 2015-2016 crop year).

Chemical and physical soil properties were determined according to agro-ecological monitoring methods (Cerbari, 1997, 2010) in field and laboratory. The cellulolytic activity was determined according to the Misustin (1978) method based on the principle of cellulose decomposition under aerobic conditions by incorporating linen tissue in the 0-30 cm soil layer.

The results of cellulolytic activity were evaluated according to Table 1.

Table 1. Values of cellulolytic activity on chernozems (Misustin, 1978)

Index level	Cellulolytic activity
Very low	< 36
Low	36-52
Middle	52-68
Great	68-84
Very great	> 84

RESULTS AND DISCUSSIONS

The carbonate chernozem of researched agroecosystem is characterized by the sub-moderate humus content (2.4% in 0-30 cm soil layer), the sum of Ca^{++} and Mg^{++} in arable layer is about 22.0 mg/100 g soil. Carbonates are present throughout the profile, ranging from 1% in the upper layer to 8% at a depth of 110-120 cm. Soil reaction is slightly alkaline.

Soil tillage lead to physical properties change, creating in some cases favourable conditions for microorganism's activity. With the purpose to follow soil cellulolytic activity at different conditions, this one was studied under conventional (Tillage) and No-till soil tillage systems (Tables 2 and 4) at different weather conditions registered during two vegetation periods - May-June and July-August of 2015-2016 crop year (Figure 2). Also, it was researched cellulolytic activity depending on depth and tissue layout toward roots of sunflower plants (Tables 2 and 4, Figure 1).

Table 2. Cellulolytic activity (%) depending on soil tillage system, May-June 2016

Depth, cm	Tissue location	Tissue breaking, % to the initial mass	Average	Index level
Tillage				
0-10	On the row	46.7	46.5	Low
	Between the rows	45.4		
	On the row	47.3		
10-20	On the row	51.1	49.2	Low
	Between the row	47.4		
	On the row	49.2		
20-30	On the row	53.2	50.7	Low
	Between the rows	48.9		
	On the row	50.0		
No-till				
0-10	On the row	29.2	31.1	Very low
	Between the rows	30.6		
	On the row	33.4		
10-20	On the row	30.0	30.1	Very low
	Between the rows	28.6		
	On the row	31.8		
20-30	On the row	33.0	32.7	Very low
	Between the rows	30.2		
	On the row	34.8		

According to the data, the cellulolytic activity under sunflower agrocoenoses during May-June period for Tillage variant varies within the limits of 47-51% in 0-30 cm soil layer, and for No-till variant is lesser - 31-33%.

Table 3. Physical soil conditions under sunflower agrocoenoses, May 2016

Depth, cm	Moisture, %		Bulk density, g/cm^3		Penetration resistance, kgf/cm^2	
	Tillage	No-till	Tillage	No-till	Tillage	No-till
0-10	17.7	16.8	1.18	1.35	5.1	15.0
10-20	18.2	16.8	1.20	1.37	9.7	17.5
20-30	19.0	17.1	1.29	1.34	16.3	20.8
30-40	18.9	19.5	1.26	1.33	14.7	18.0
40-50	20.7	18.9	1.28	1.18	16.3	18.9

Table 4. Cellulolytic activity (%) depending on soil tillage system, July-August 2016

Depth, cm	Tissue location	Tissue breaking, % to the initial mass	Average	Index level
Tillage				
0-10	On the row	24.2	23.4	Very low
	Between the rows	20.9		
	On the row	25.1		
10-20	On the row	26.0	24.5	Very low
	Between the rows	21.4		
	On the row	26.1		
20-30	On the row	26.9	25.4	Very low
	Between the rows	22.3		
	On the row	26.9		
No-till				
0-10	On the row	22.8	20.8	Very low
	Between the rows	19.6		
	On the row	20.1		
10-20	On the row	23.3	23.9	Very low
	Between the rows	22.6		
	On the row	25.8		
20-30	On the row	26.9	25.1	Very low
	Between the rows	23.3		
	On the row	25.2		

Some physical soil properties (moisture, bulk density, penetration resistance), determined in May, show that on Tillage variant soil moisture is higher by 1-2%, comparative with No-till variant, and the bulk density and penetration resistance data indicates a more afforested settlement of the arable layer on tilled variant (Table 3). These better physical conditions (moisture, O_2 supply) explain the cause of a higher cellulolytic activity on Tillage.

The researches has shown that soil cellulolytic activity under conservation tillage system - No-till is less with 15-20%, comparative with plowing variant during May-June period - characterized by sufficient rainfall (monthly precipitation was higher than multiannual average) and moderate temperatures (16.5-22.1°C) (Figure 2).

The July-August dry weather conditions (precipitations much lower than multiannual average) have inhibited cellulolytic activity under conventional soil tillage from low (47-51%) to very low (23-25%), being similar to the No-till variant (21-25%) where cellulolytic activity also diminished with 10% from May-June to July-August period.

The most populous area of microorganisms is near of plant roots. This explains better decomposition of tissues located on rows, comparative to that located between rows (Figure 1).

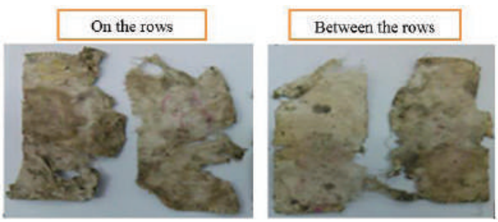

Figure 1. Cellulolytic activity depending on tissue location in sunflower agrocoenoses

Data obtained in both variants (Tillage and No-till) during two vegetation periods reveals that microorganisms activity grows slightly - with 2-5% from surface soil layer (0-10 cm) to 20-30 cm soil layer. This is due to soil moisture increasing with depth.

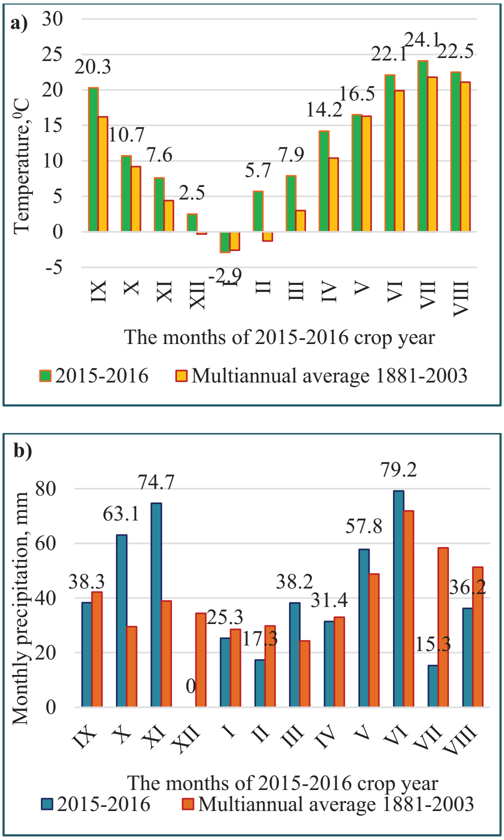

Figure 2. Meteorological conditions of 2015-2016 crop year, DES „Chetrosu": a) Temperature; b) Precipitation

CONCLUSIONS

Soil cellulolytic activity under conservation tillage system - No-till was less with 15-20%, comparative with plowing variant during May-June period - characterized by sufficient rainfall and moderate temperatures. The July-August dry weather conditions have inhibited cellulolytic activity under conventional soil tillage from low (47-51%) to very low (23-25%), being similar to the No-till variant (21-25%), where cellulolytic activity also diminished with 10% from May-June to July-August period.

The incorporation of linen tissues at different depths showed that cellulolytic activity is higher in the 20-30 cm layer and it is directly affected by the soil moisture.

The most populous area of microorganisms is near of plant roots. The better decomposition of tissues occurred on rows, comparative to that located between rows.

Cellulolytic activity is influenced by soil moisture, O_2 supply, soil tillage system, weather conditions and other factors that act directly and indirectly on microorganisms in the soil.

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INFLUENCE OF WASTES FROM THE PRODUCTION OF ALCOHOLIC BEVERAGES ON THE PRODUCTION AND QUALITY OF AGRICULTURAL CROPS

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Abstract

The paper describes the results of the application of wastes from the production of alcoholic beverages (wine yeast, vinasse and grain mashes) on the productivity and quality of agricultural production. It was established that the application of wine yeast at the rate of 13-26 t/ha provided an increase in grape production (Sauvignon) on an average for seven years of 1.4-2.3 t/ha. The harvest increase at the incorporation of the vinasse in the dose of 300-600 m^3/ha was on average for seven years of 0.7-0.8 t/ha. Grain mashes in the dose of 47-94 m^3/ha resulted in average crop increase for six years of 1000-1400 kg/ha of grain units. It was found that fertilization with wastes from wine factories has not diminished the quality of the obtained wines. The physico-chemical composition is in line with the requirements for quality wines. The researched wines are distinguished by good organoleptic qualities (7.8-7.9 points) and according to the typicality they correspond to normative acts. The applied grain mashes helped synthesize and accumulate crude protein in grains. The total protein gain collected in six years was 1140-1320 kg/ha.

Key words*: wastes, wine yeast, vinasse, grain mashes, productivity, quality of production.*

INTRODUCTION

According to the statistical data in the Republic of Moldova from 130 companies producing alcoholic beverages and wines, about 100 thousand tons annually of residual materials are formed annually. Continuously accumulation of residues causes a polluting impact on the environment, soil and surface waters (Duca et al., 2001; Duca, 2011; Gaina, 1990). The origin of the waste is agriculture.
In 100 tons of waste there are 28 thousand tons of organic matter, 180 tons of nitrogen, 82 tons of phosphorus and 257 tons of potassium.
So it will be fair as they return to soil through fertilization. International research in terms of characteristics and use in agriculture of wastes from the production of alcoholic beverages are very few (Nicolic et al., 2006; Luz et al., 2009) and in the Republic of Moldova they are missing.
In this context, it is necessary to solve the waste problem by using them in agriculture as fertilizers. The purpose of the paper is to determine the influence of waste from the production of alcoholic beverages on plant productivity and production quality.

MATERIALS AND METHODS

The research and observations were made on cambic (leached) chernozem from Tehnological-experimental Station „Codru”, located in Codru community, Chisinau municipality, during 2011-2017 years. To test the effect of these wastes on productivity and production quality, two field experiments were organized. Waste was applied in autumn before the soil plough. The statistical processing of the data was done after Dospehov (1990).

RESULTS AND DISCUSSIONS

Productivity of agricultural plants. From the measurements and calculations carried out during all years of experimentation, it was established (Table 1) that the application of the 13 and 26 t/ha of wine yeast provided a significant increase in grape harvest on average (2011-2017) for seven years of 1.3 and 2.3 t/ha, with 14 and 24% more compared to unfertilized control (9.5 t/ha). Significant influence on the productivity of grape plants had vinasse incorporated in the dose of 300 and 600 m^3/ha per year. The crop increase on average for seven years was 0.7-0.8 t/ha or with 7-8% more than the control.

Table 1. Influence of wine waste on the Sauvignon grape harvest obtained on cambic chernozem, t/ha. The Technological-experimental Station „Codru”

Variant	Grapes harvest, years							Average for 7 years		
	2011	2012	2013	2014	2015	2016	2017	harvest, t/ha	Increase compared to the control	
									t	%
Control	9.8	7.6	10.6	9.8	10.8	7.4	10.4	9.5	-	-
Wine yeast, 13 t/ha	10.8	8.7	11.9	12.0	11.9	8.6	11.7	10.8	1.3	14
Wine yeast, 26 t/ha	10.9	8.8	14.1	13.9	12.8	9.0	13.2	11.8	2.3	24
Vinasse 300 m^3/ha	10.8	8.7	12.0	10.5	11.7	7.6	10.0	10.2	0.7	7
Vinasse 600 m^3/ha	10.6	8.5	12.6	10.6	11.8	7.6	10.3	10.3	0.8	8
LSD 0.5%	0.60	0.64	0.94	0.73	0.67	0.92	0.82	0.65	-	-

Table 2 presents the data that highlights the effects of grain fertilization on field crops harvested on cambic chernozem.

Research in the years 2012-2017 has shown that grain mashes fertilization has led to a statistically significant increase in crop yields. The grain mashes applied annually at doses of 47 and 94 m^3/ha (equivalent to N_{120} and N_{240}) resulted in a crop increase on average for 6 years of 1001-1384 kg/ha of grain units or 32-44% compared to the unfertilized control.

Table 2. Influence of cereal crop fertilization on crop yields, kg/ha. The Technological-experimental Station „Codru”

Variant	Crop production						Average for 7 years, grain units		
	2012, sunflower	2013 winter wheat	2014, sunflower	2015, corn	2016, winter wheat	2017, soy beans	harvest, kg/ha	Increase compared to the control	
								kg	%
Control	1230	3818	1170	2515	6100	1830	3125	-	-
Grain mashes 47 m^3/ha	1840	5673	1790	3473	6700	2373	4126	1001	32
Grain mashes 94 m^3/ha	2070	6183	1980	3750	7300	2568	4509	1384	44
LSD 0.5%	223	520	172	653	573	241	528	-	-

Qualitative indices of agricultural production

For the oenological researches regarding the quality of the wine from the experienced vineyard plantation, grapes from all three variants were harvested. The content of sugar and acids in the extracted juice was determined yearly (Table 3).

The analyzes performed (2011-2017) show that the sugar content in grapes from the fertilized variants was in average 203-212 g/dm^3 with an acid accumulation of 7.0-7.6 g/dm^3.

Table 3. Sugar content and acids accumulation in Sauvignon grapes, at application of waste from the production of alcoholic beverages. Technological-experimental Station „Codru” on average for 2011-2017 (ISPHTA data)

Variant	Grapes harvest, kg	Sugar content, g/dm^3	Acids accumulation, g/dm^3
Control	50	204	7.8
Vinasse (K_{450}), 300 m^3/ha per year	50	212	7.2
Vinasse (K_{900}), 600 m^3/ha per year	50	212	7.5
Wine yeast (N_{100}), 13 t/ha per year	50	203	7.0
Wine yeast (N_{200}), 26 t/ha per year	50	210	7.6

In February-March 2012-2016 in the Laboratory of „Strong drinks and by-products” of ISPHTA, physico-chemical research on the quality of the obtained wines was carried out. In wine samples were determined alcohol concentration, mass concentration of volatile acids, mass concentration of sulfuric acid, pH of wines. The obtained results are presented in Table 4.

Table 4. Physico-chemical indices of white wines of the Sauvignon variety. On average for the years 2012-2016 (ISPHTA data)

Indices and unit of measure	Fertilization variant				
	Control	Vinasse (K_{450}), 300 m^3/ha per year	Vinasse (K_{900}), 600 m^3/ha per year	Wine yeast (N_{100}), 13 t/ha per year	Wine yeast (N_{200}), 26 t/ha per year
Alcohol, % vol	12.57	13.46	13.42	12.99	11.68
Titrable acidity, g/dm^3	5.3	5.5	4.8	5.8	5.4
Volatile acidity, g/dm^3	0.37	0.38	0.49	0.32	0.29
Sulfur dioxide, mg/dm^3	35.2	40.32	26.62	30.72	47.32
Free sulfur dioxide, mg/dm^3	11.52	17.92	14.08	15.36	14.08
pH	3.1	3.2	3.1	3.1	3.2
Organoleptic note	7.87	7.87	7.83	7.85	7.84

Due to their advanced carbohydrate content, the wines have a strength of over 13% vol. The concentration of sulphur dioxide and free sulphur dioxide is 30.7-47.3 mg/dm^3 and 14.1-17.9 mg/dm^3, respectively. The pH is equal to 3.1-3.2 units.

Wine, the raw material of Sauvignon white grape variety is relatively clear, the color is of pale straw with greenish tones, flavor and taste are simple, pure with moderate acidity and residual sugar and organoleptic note with a value of 7.8-7.9 points. So it has been found that fertilization with waste from wine factories has not diminished the quality of the obtained wines. The physico-chemical composition is in line with the requirements for quality wines. The researched wines are distinguished by good organoleptic qualities and, according to their typicality, correspond to the normative acts.

A higher protein content (Table 5) was established annually in the harvest of cereals treated with grain mashes at a dose of 47-94 m^3/ha (equivalent to N_{120}-N_{240}).

Since the application of grain mashes has not only increased the concentration of the vital substances in the crop but also favored the increase of its mass, it has been obtained that the mass of harvested protein and fat has increased considerably compared to the control. The protein mass collected in six years increased in comparison with the control with 1141-1320 kg/ha. As regards the fat content index, a significant increase was observed. The value of sunflower fat growth (2012) was 248-344 kg/ha (42.6-42.7%), and in 2014 also for sunflower 266-358 kg/ha (48.7%). The current year (2017) was grown soybean. The value of the fat increase was 135-176 kg/ha (22.6-22.7%).

Table 5. Quality indices of the main crops fertilized with grain mashes

Indices and units of measurement	Variant		
	Control	Grain mashes (N_{120}), 47 m^3/ha anual	Grain mashes (N_{240}), 94 m^3/ha anual
Sunflower, 2012			
Protein content,%	16.2	16.3	16.2
Amount of protein, kg/ha	199	300	335
Protein increase, kg/ha	-	101	136
Fat content,%	43.7	42.7	42.6
The amount of fat, kg/ha	538	786	882
Fat increase, kg/ha	-	248	344
Winter wheat, 2013			
Protein content,%	7.9	11.2	10.0
Amount of protein, kg/ha	302	635	618
Protein increase, kg/ha	-	333	316
Sunflower, 2014			
Protein content,%	14.2	17.3	18.4
Amount of protein, kg/ha	166	309	364
Protein increase, kg/ha	-	143	198
Fat content,%	51.8	48.7	48.7
The amount of fat, kg/ha	606	872	964
Fat increase, kg/ha	-	266	358
Grain corn, 2015			
Protein content,%	5.15	5.46	5.58
Amount of protein, kg/ha	250	288	342
Protein increase, kg/ha	-	38	92
Winter wheat, 2016			
Protein content,%	8.0	11.3	10.5
Amount of protein, kg/ha	306	641	649
Protein increase, kg/ha	-	335	343
Soy beans, 2017			
Protein content,%	30.8	31.8	31.1
Amount of protein, kg/ha	564	755	799
Protein increase, kg/ha	-	191	235
Fat content,%	22.1	22.7	22.6
The amount of fat, kg/ha	404	539	580
Fat increase, kg/ha	-	135	176
Total protein gain collected in six years, kg/ha	-	1141	1320

CONCLUSIONS

The use of wine yeast as fertilizer provided a significant increase in the production of grapes (Sauvignon) on average for seven years of 1.4-2.3 t/ha. The harvest increase at the incorporation of vinasse on average for seven years of 0.7-0.8 t/ha. Grain mashes provided average crop increase for six years of 1001-1384 kg/ha of grain units or 32-44% of the unfertilized control.

It has been found that fertilization with waste from wine factories has not diminished the quality of the obtained wines.

The physico-chemical composition is in line with the requirements for quality wines.

The wines distinguish by good organoleptic qualities and, according to their typicality, correspond to the normative acts.

The applied grain mashes helped synthesize and accumulate crude protein in grain production. The total protein gain collected in six years consisted of 1141-1320 kg/ha.

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ASPECTS REGARDING THE USAGE OF GROUND AUGERS FOR DRILLING HOLES SAPLINGS IN FORESTRY SECTOR

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Abstract

This paper presents the results of our research regarding the usage of ground augers in the forestry sector for drilling holes in order to plant saplings. In order to carry out the research, we settled in two forest divisions in the plains of the West of Romania so that we could have four different types of soils which are representative for that specific area.
The objectives of the research were to make a comparative determination, on different types of soil, of the qualitative parameters, among which the most important ones are: timing of drilling holes, fuel consumption for the drilling of the hole, evacuate ratio, degree of evacuation of the soil from the hole, medium range scattering, settlement angle, resistance to penetration, resistance to shearing, degree of scattering of the soil taken out from the hole, degree of loosening of the soil taken and left in the hole, using the Stihl BT 121 auger in order to establish its technical efficiency.
In order to observe the influence which, the drilling of holes has on its walls, we measured the resistance to penetration and resistance to shearing every 10 cm at a 30 cm depth, the proper depth for planting small-sized saplings, on two opposing sides, so that we could get the most probable values of these physical-mechanical properties of the soil. We started by measuring the particle size distribution and the main physical properties of the soil (moisture, bulk density and total porosity) and then, we determined the duration of drilling holes, split times (duration of movement from one hole to the other) and the fuel consumption when using a Stihl BT 121 auger equipped with a 150/200 mm diameter drill.
The average values for the duration of digging and the fuel consumption for each type of soil was as follows: 1st type of soil - timing 11.7 ± 3.09 sec. and average consumption 4.31 ± 1.14 ml; 2nd type of soil - timing 12.0 ± 3.76 sec. and average consumption 5.75 ± 1.80 ml; 3rd type of soil - timing 12.06 ± 1.99 sec. and average consumption 4.76 ± 0.79 ml; 4th type of soil - timing 9.83 ± 2.52 sec. and average consumption 3.49 ± 0.89 ml (mean ± SD).
The usefulness of the present paper stays in the research data collected, processed, analyzed and valorized in order to offer a pertinent study material, which could indeed be used by specialists in designing the process for obtaining, through a mechanized means, the holes for planting small-sized saplings on a horizontal ground, using the Stihl BT 121 auger.

***Key words**: ground auger, physical properties, timing of drilling holles.*

INTRODUCTION

The need to afforest greater and greater surfaces in Romania as a result of widely known causes, together with the development of forestry nurseries that are able to produce a certain quantity of saplings to cover the production needs, imply an enormous work volume in the afforestation sector which is difficult to carry out only by manual means.
In the future, the afforestation activity will become compulsory in even greater surfaces. For this reason, we consider that the optimal solution in this case is the mechanization of hole digging for planting saplings by using ground augers.
From this point of view, there is a wide range of ground augers able to mechanically dig holes for saplings, which are available on the market. In order to comparatively observe the performance rate, we used a Stihl ground auger. From the very many types of machinery available in Romania, we have chosen for the study regarding the auger performance in terms of fuel consumption: the Stihl BT 121 auger (Popescu, 1984; Popescu et al., 2013).
The research was carried out to observe the auger efficiency and to make measurements regarding the quantity and auger performance in a shift (8 hours) (Popescu, 2006; Popescu et al., 2006; Boja et al., 2011).

In order to encompass the ground diversity in forests, we chose to make our research on four different types of soil (1st soil, 2nd soil, 3rd soil, 4th soil).

The present research is carried out only on plains, and fuel consumption are linked to the nature of the ground in terms of particle size analysis.

The soil is the environment of the growth and development of the saplings, because in it and through it there are the nutritive elements and the activity of the micro-organisms in the context of a normal thermo-aero-hydro regime. It can be penetrated by the roots of the plants, it is stirred, it contains water, air and living matter (flora and fauna) and it represents the necessary support for the growth and development of the saplings (Boja et al., 2012).

The characteristic of the soil as a growth and development environment for the plans is given by a series of properties (texture, structure, porosity, compaction, reaction, humus content and nutritive elements), expressed globally through the notion of fertility (Boja et al., 2011; Boja et al., 2010; Onet et al., 2016).

In order to obtain pertinent results, the research was done according to a complex methodology, with a novelty character in this domain, which gave the possibility to study different technical aspects of usage of the motto-borer.

Because of the compaction, while digging holes for planting saplings, there are several phenomena of friction occurring which increase the resistance to penetration through the walls of the hole. For the same reason, the soil offers resistance to some mechanical, exterior forces, presenting resistance to compression, shearing and penetration (Popescu, 2006).

Machineries that realize digging holes to plant seedlings are part of the large group of ground working machines whose active components have a moving rotation generated by a power source. The specific of these machineries is the fact that the soil is prepared by chipping, action from which the soil mobilization and aeration is carried out with or without putting out the soil from the hole.

The principle of this action is not exclusively reserved to machineries digging holes for seedlings. This principle exists in other machineries whose destination is to prepare the soil to be a germinating bed, to maintain crops along rows gap, a.s.o. The same principle has applicability on a large scale in the wood and metal industries (Popescu et al., 2006; Boja et al., 2011).

MATERIALS AND METHODS

The experimental research was conducted in two forest divisions in the plains (Figure 1). For this purpose, we chose the soils which are most frequently spread in those areas. In this respect, we made measurements in order to determine the moisture, the bulk density, the total porosity and the particle size analysis of the soils. The particle size analysis of the soils was carried out in a specialized laboratory.

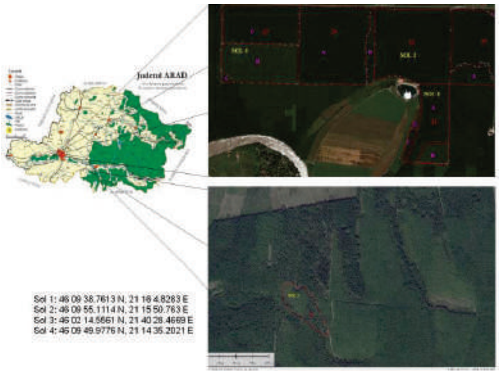

Figure 1. Experimental field map

We determined the fuel consumption and digging duration for each hole, but also the split times (duration of movement from one hole to the other).

The digging duration and the split times were determined by using a timer; for determining the fuel consumption, we placed inside the tank a precise quantity of fuel and after depleting it, we related it to the digging duration and we multiplied it with the digging time allotted for each hole, according to the relation (1):

$$Q_n = \frac{Q}{\sum T} \cdot t_n \quad (1)$$

where: Q_n is the fuel quantity needed for each hole;

Q -total quantity of fuel placed in the tank;

$\sum T$-total sum of digging duration of the holes;

t_n-duration of digging of a hole.

The technical characteristics of the ground auger used in our research are given in Table 1, and its photography appears in Figure 2.

Figure 2. Ground auger Stihl BT 121 (www.stihl.ro)

The technical characteristics of the ground auger Stihl BT 121 are given in Table 1.

Table 1. Technical data of the ground auger Stihl BT 121 (www.stihl.ro)

Cylindrical capacity	30.8 cm^3
Weight	9.4 kg
Power	1.3/1.8 kW/CP
Level of vibrations left/right	2.2/2.5 m/s^2
Speed of rotation	190 1/min.
Level of acoustic pressure	103.0 dB (A)
Level of acoustic pressure	109.0 dB (A)

In this paper, we presented the results gathered after digging the holes for planting saplings in the previously unprepared ground, taking into account: the durations implied by digging holes according to the physical-mechanical properties of the soil and the fuel consumption needed for digging a hole.

The physical properties were determined by using the method of the cylinders with a constant volume of 100 cm^3, carrying out five repetitions at different depth, from 10 to 10 cm until the depth of 30 cm. The methods of analysis and interpretation of the results as well as the work procedure for the determination of the physical – mechanical properties are those indicated in the specialized literature (Boja et al., 2012; Boja et al., 2013; Boja et al., 2013).

In order to reach our objectives, we have dug n holes for each type of soil chosen for the experiment, placed on a previously unprepared horizontal ground, using the Stihl BT 121 auger with a 150/200 mm drill, until exhausting the whole quantity of fuel placed in the tank (500 ml) (Boja et al., 2012; Boja et al., 2012; Boja et al., 2012).

In order to observe the influences which the digging of holes have on their walls, we measured the resistance to penetration and the resistance to shearing on the holes' walls from 10 to 10 cm until the depth of 30 cm, on two opposing sides, so as to get the most probable values for these physical-mechanical properties of the soil, depth sufficient enough for the planting of small-sized saplings. The placement of samples for the resistance to penetration and shearing on the walls of the holes is given in Figure 3.

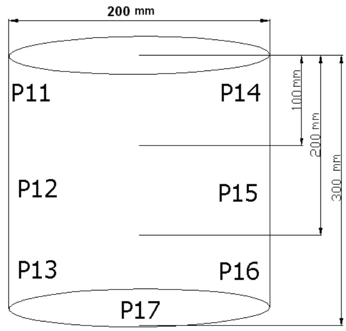

Figure 3. Placement of samples for the resistance to penetration and shearing on the walls of the holes

The degree of scattering of the evacuated soil from the hole was expressed by the ratio of the maximum diameter of scattering or of the diameter at which is deposited most of the quantity of soil, at the diameter of the hole. The degree of evacuation of the soil from the hole was expressed by the ratio between the volume of the soil evacuated from the hole and the volume of the soil left in the hole at a 30 cm - depth. The elements measured for the determination of these qualitative indexes are given in Figure 4.

In order to accomplish the objectives we have for each type of soil chosen for the experiment, placed on a horizontal ground, previously unprepared, using the Stihl BT 121 motto-borer with a 150/200 mm drill.

Statistical analysis. Data was subjected to two-way analysis of variance (ANOVA) ($P = 0.05$), and in order to determine the samples means statistical differences the Tukey test of pairwise comparisons was done (Minitab software, Minitab, Inc. Quality Plaz, 1829 Pine Hall Road, State College, PA 16801 USA). Multivariate analysis was done following the sequence: principal component analysis (PCA), and (P = 0.05), in order to determine the possible variables grouping and samples clustering (Hammer et al., 2001).

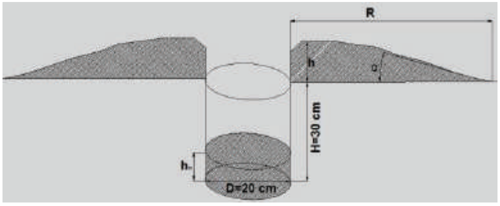

Figure 4. Determination of the degree of scattering and degree of evacuation of the soil in the hole: *H - depth of digging, hn - height of the un-evacuated soil, h - height of the soil bed evacuated, D - diameter of the hole, α - angle of setting of the evacuated soil, R - radius of scattering of the evacuated soil (mean R)*

RESULTS AND DISCUSSIONS

a. Physical properties

The state of aeration of the processed soil in the natural setting can be expressed through specific issues such as: bulk density and total porosity (Maior et al., 2016; Boja et al., 2016).

The types of soil on which the research was carried out are: gleysoil the muddy subtype (soil 1), alluvial soil the vertical-gleyed subtype (soil 2), brown typically luvic soil (soil 3) and a alluvial soil-typical (soil 4). The physical properties determined during the digging of the holes and the particle size distribution of the soil are presented with average values in Tables 2 and 3.

We could notice the fact that the holes were dug when the values of soil moisture were ranging from 20.75 to 24.11% for the 0-10 cm depth, 19.46-22.73% for 10-20 cm depth and 8.74-20.09% for the 20-30 cm depth.

In order to show the influence of the soil type (particle size distribution) and of the physical properties of the soils included in the experiment on the digging duration and fuel consumption, all the holes were dug on a previously unprepared ground, which can be noticeable in the values of total porosity that vary as follows: for 0-10 cm between 35.54-37.89%; for 10-20 cm between 33.28-37.43% and for 20-30 cm between 31.25-36.45%.

Table 2. The values of physical properties of the soils analyzed (mean ± SD)

Type of soil	Physical properties	Depth 0-10 cm	10-20 cm	20-30 cm
SOIL 1 gleysoil	Soil moisture, %	24.11 ± 1.2	22.73 ± 1.0	20.09 ± 0.8
	Bulk density, g/cm^3	1.62 ± 0.23	1.69 ± 0.19	1.72 ± 0.06
	Total porosity, %	37.89 ± 2.51	37.43 ± 2.24	36.45 ± 1.15
SOIL 2 alluvial soil – vertical gleyed	Soil moisture, %	20.75 ± 0.9	19.46 ± 0.7	17.38 ± 0.5
	Bulk density, g/cm^3	1.70 ± 0.02	1.75 ± 0.01	1.73 ± 0.00
	Total porosity, %	36.97 ± 1.32	35.73 ± 1.11	35.19 ± 0.92
SOIL 3 brown typically luvic	Soil moisture, %	22.43 ± 0.8	21.10 ± 0.5	8.74 ± 0.3
	Bulk density, g/cm^3	1.69 ± 0.05	1.71 ± 0.03	1.73 ± 0.01
	Total porosity, %	37.43 ± 1.05	36.31 ± 0.96	36.09 ± 0.53
SOIL 4 alluvial soil – typical	Soil moisture, %	23.35 ± 0.5	21.68 ± 0.3	19.54 ± 0.1
	Bulk density, g/cm^3	1.64 ± 0.01	1.58 ± 0.01	1.51 ± 0.00
	Total porosity, %	35.54 ± 2.52	33.28 ± 2.01	31.25 ± 1.85

Table 3. Average values of the granulometric analysis at different depths of prelevation

Type of soil	Depth of prelevation	Values of the granulometric analysis: Sand (Coarse + Fine)	Dust (I + II)	Clay
SOIL 1 gleysoil	0-10	36.78	33.88	29.54
	10-20	47.78	25.08	27.34
	20-30	41.18	30.38	28.64
SOIL 2 alluvial soil – vertical gleyed	0-10	40.78	38.78	20.64
	10-20	39.38	37.18	23.84
	20-30	41.98	33.08	25.24
SOIL 3 brown typically luvic	0-10	38.78	36.33	25.09
	10-20	43.58	31.13	25.59
	20-30	41.58	31.73	26.94
SOIL 4 alluvialsoil – typical	0-10	40.36	38.36	21.28
	10-20	40.63	36.08	23.29
	20-30	41.2	33.95	24.85

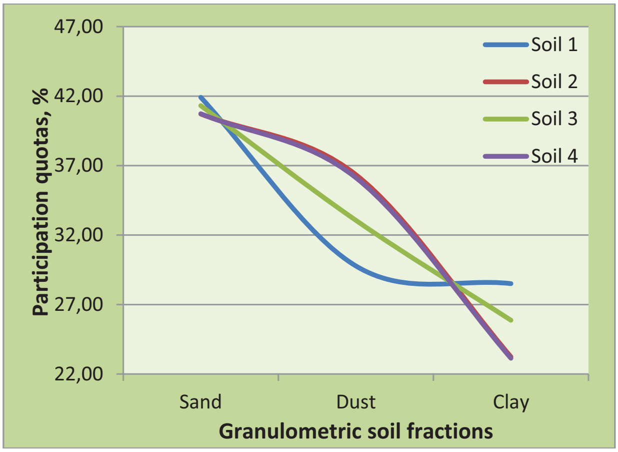

Figure 5. Granulometric curves analysis of the soils

When analysing the granulometric curves presented in Figure 5, one can notice the fact that there was a sandy-dusty-clay-like texture in all the soils encompassed in the experiment at a participation quota that scarcely varies, with the exception of the 1st soil where the particle size distribution is slightly different: sandy-clay-like-dusty texture.

b. Qualitative parameters

Significant differences between the borer type and between the four types of soils studied in relation to the physical and mechanical properties of the soil were assessed using two-way ANOVA (Figures 6-13), principal component analysis (PCA) (Table 4, Figure 14). The highest value for the duration of digging was registered for the 2nd type of soil (17.708 s), while the lowest value appeared in the case of the 1st type of soil (8.553 s). Taking into account the diameter of the drill and the type of soil, the maximum digging duration was noted with the 15-cm diameter drill on the 2nd type of soil (D15*Soil02 = 23.420 s), while the minimum one was found with the 15-cm diameter drill on the 1st type of soil (D15*Soil01 = 5.407 s).

Analysed only from the perspective of the type of soil, the fuel consumption reached maximum values on the 2nd type of soil (5.649 ml) and minimum ones on the 1st type of soil (4.513 ml). Analysed both from the perspective of the type of soil and the type of drill, the fuel consumption reached maximum values with the 15-cm diameter drill on the 4th type of soil (D15*Soil04 = 6.863 s) and minimum ones with the 20-cm diameter drill on the 4th type of soil (D20*Soil01 = 3.486 s). In the present case, the amplitude of variance of fuel consumption can reach values of ± 3.377 ml in the same pedological conditions.

The volume of the earth removed reached maximum values in case of the 4th type of soil (0.180 m^3) and minimum ones with the 1st type of soil (0.005 m^3).

The same values also apply when we take into account both the type of soil and drill: a maximum value was acquired in the case of the 15-cm diameter drill on the 4th type of soil (D15*Soil04 = 0.352 m^3) and a minimum one with the 15-cm diameter drill on the 1st type of soil (D15*Soil01 = 0.003 m^3).

The removal ratio acquires maximum values for the holes dug in the 3rd type of soil and minimum ones for the 2nd type. However, when we analyse both the type of soil and drill, maximum values appear with the 20-cm diameter drill on the 4th type of soil (D20*Soil04 = 6.012) and minimum ones with 15-cm diameter drill on the 4th type of soil (D15*Soil04 = 2.903).

The average radius of scattering of the earth removed had maximum values in the case of the 4th type of soil (34.355 cm), and miminum ones with the 2nd type of soil (13.495 cm). The same situation occurs when we analyse both the type of soil and drill: a maximum value is reached with the 15-cm diameter drill on the 4th type of soil (D15*Soil04 = 36.125 cm) and a minimum one with the 20-cm diameter drill on the 2nd type of soil (D20*Soil02 = 12.899 cm).

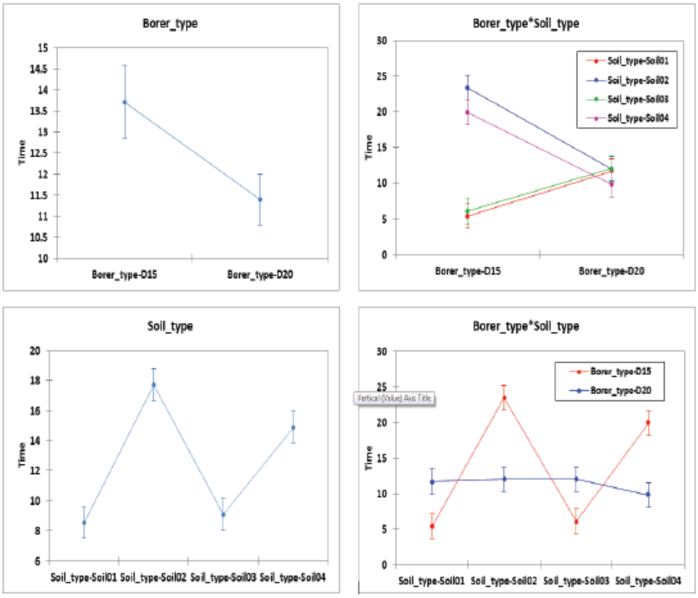

Figure 6. Interaction plots (two-way ANOVA) for the factors soils type and borer type for the investigated timing of drilling holes (Time)

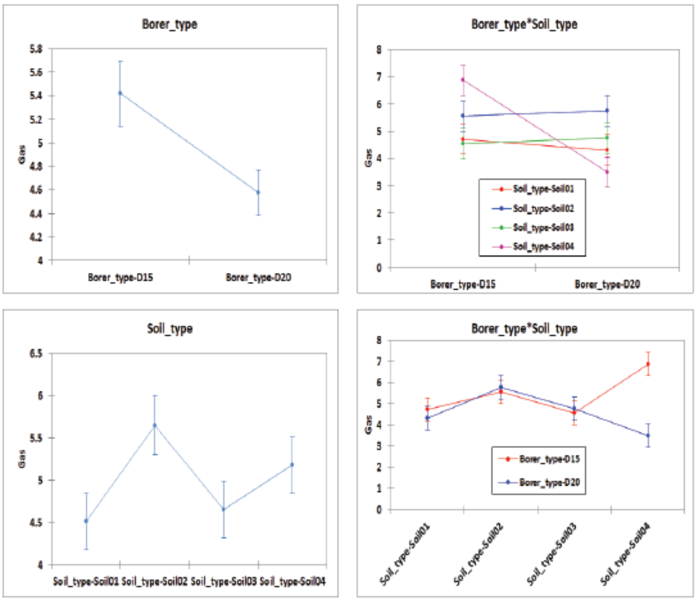

Figure 7. Interaction plots (two-way ANOVA) for the factors soils type and borer type for the investigated fuel consumption (Gas)

The angle of placement of the earth removed reaches maximum values in the case of the 3rd type of soil (22.578^o), and minimum ones in the 1st type of soil (11.213^o).

By analysing this qualitative index both from the point of view of the type of soil and drill, a maximum value is reached with the 20 cm diameter drill on the 2nd type of soil (D20*Soil02 = 32.399^o and a minimum one with the 15 cm diameter drill on the 1st type of soil (D15*Soil01 = 9.597^o).

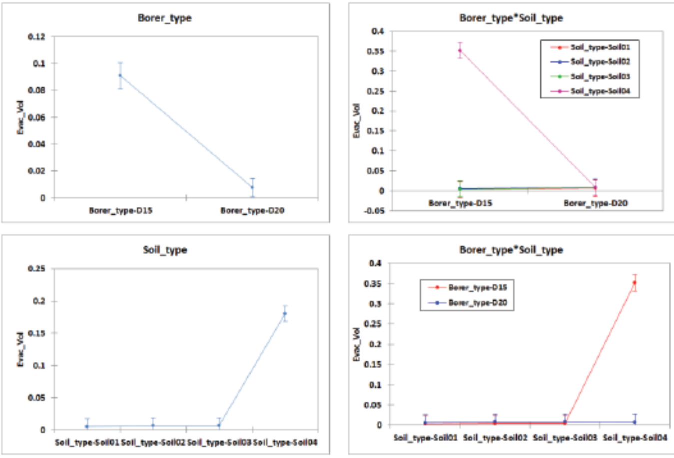

Figure 8. Interaction plots (two-way ANOVA) for the factors soils type and borer type for the investigated degree of evacuation (Evac_Vol)

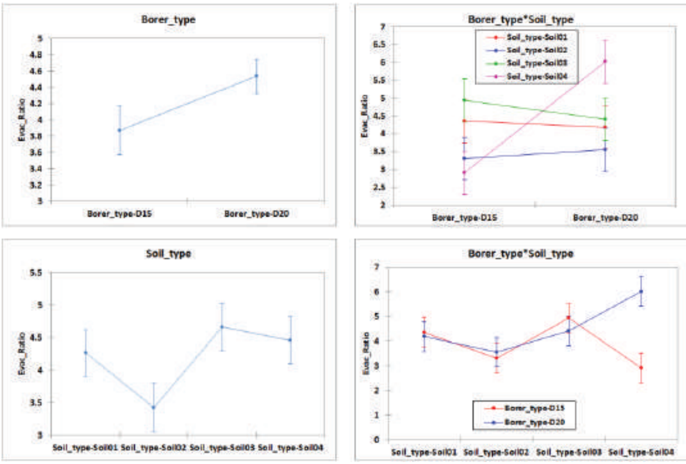

Figure 9. Interaction plots (two-way ANOVA) for the factors soils type and borer type for the investigated evacuate ratio (Evac_Ratio)

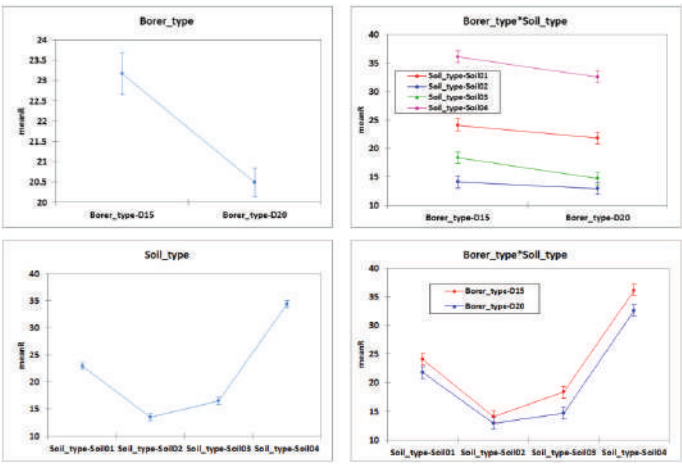

Figure 10. Interaction plots (two-way ANOVA) for the factors soils type and borer type for the investigated medium range scattering (mean R)

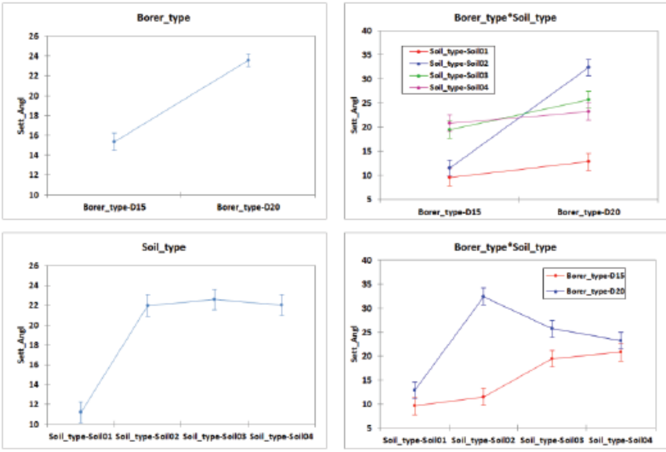

Figure 11. Interaction plots (two-way ANOVA) for the factors soils type and borer type for the investigated settlement angle (Sett_Angl)

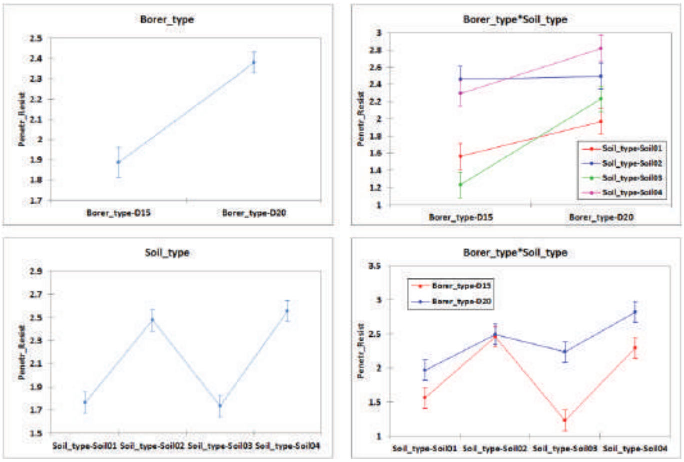

Figure 12. Interaction plots (two-way ANOVA) for the factors soils type and borer type for the investigated resistance to penetration (Penetr_Resist)

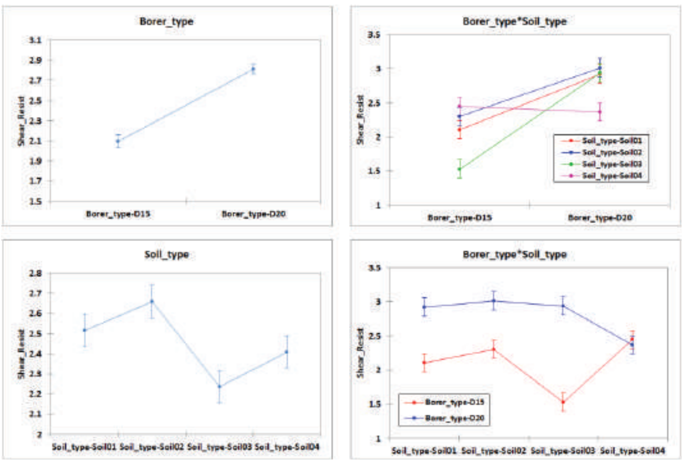

Figure 13. Interaction plots (two-way ANOVA) for the factors soils type and borer type for the investigated resistance to shearing (Shear_Resist)

By analysing the values of the penetration resistance, only from the point of view of the soil, the highest value is met in the case if the 4th type of soil (2.557 daN/cm^2) and the lowest one in the 3rd type (1.734 daN/cm^2). Thus, there is a very low risk that saplings could experience a physiological unbalance due to the fact that their roots cannot penetrate the sides of the holes (as a result of the fact that they were pressed during execution). The same situation also occurs in the case of the analysis based on both the type of soil and drill, as we run a very low risk of pressing the sides of the holes: a maximum value appears with a 20 cm diameter drill on the 4th type of soil (D20*Soil04 = 2.822 daN/cm^2) and a minimum one with the15-cm diameter drill on the 3rd type of soil (D15*Soil03 = 1.232 daN/cm^2).
A similar situation also occurred in the case of the shear resistance measured in the holes: the highest value was acquired in the 2nd type of soil (2.658 daN/cm^2) and a minimum one in the 3rd type (2.236 daN/cm^2). The quotas are maintained for the values involving both the type of soil and drill, as the maximum value was reached with a 20-cm diameter drill on the 2nd type of soil (D20*Soil02 = 3.016 daN/cm^2 and a minimum one with the 15 cm diameter drill on the 3rd type of soil (D15*Soil03 = 1.530 daN/cm^2).
PCA analysis was calculated using the correlation matrix of the variables and the between group algorithm. First two principal components explain 65.24% from the total variance of the data. The first three principal components explain 81.89% from the total variance of the data (Table 3 and Figure 14).

Table 3. Principal components statistical results

Principal component	Eigen value	Variance (%)
1	2.84974	40.711
2	1.71729	24.533
3	1.16566	16.652
4	0.736855	10.527
5	0.456835	6.5262
6	0.0718962	1.0271
7	0.0017237	0.024624

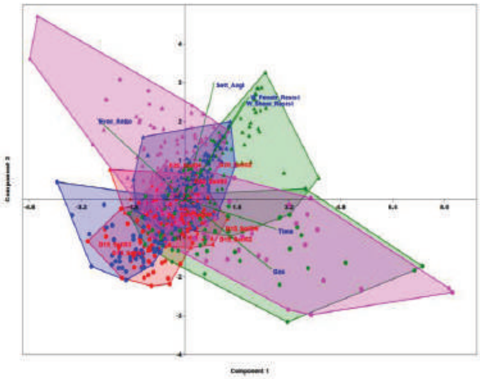

Figure 14. Principal component analysis (PCA) biplot

To alleviate the samples groups overlapping in PCA biplot, there was used the linear discriminant analysis (LDA) which uses canonical projections similar with the PCA method but aims to increase the linear distance between the samples groups (i.e. to get a better discrimination).

CONCLUSIONS

From all of the above, we can infer the following conclusions regarding the behaviour of the Stihl BT 121 auger with a 150/200 mm drill in the forestry sector and on a previously unprepared horizontal ground:
The holes were dug when the values of soil moisture were ranging from 20.75 to 24.11% for the 0-10 cm depth, 19.46-22.73% for 10-20 cm depth and 8.74-20.09 % for the 20-30 cm depth.
The values of total porosity that vary as follows: for 0-10 cm between 35.54-37.89%; for 10-20 cm between 33.28-37.43% and for 20-30 cm between 31.25-36.45%.
The average values of duration needed to dig holes (starting from the moment when the drill penetrated the soil, bored until reaching the 30 cm depth and was pulled out of the hole) vary between 9.83 ± 2.52 and 12.06 ± 1.99 seconds (mean ± SD).
The amplitude of average variation (the mean between the difference of maximum and minimum values) for the duration of digging holes is 13.36 sec., which is a high value. However, in terms of particle size distribution, the soil texture is similar. These differences

occur as a result of physical properties of the different soils while digging.

The average value of split times derived from hole digging (time lapse of the auger put on, from one hole to the other, according to the planting layout: 1, 2, 3 or 4 metres), is at a 1 m distance, 2.71 ± 1.41 sec.; at 2 m, 5.42 ± 2.83sec.; at 3 m, 8.14 ± 4.24 sec. and at 4 m, 10.85 ± 5.66 sec. (mean ± SD).

The average values of fuel consumption for the four types of soil are: 3.49 ± 0.89 for the 4th type of soil, 4.31 ± 1.14 ml for the 1st type of soil, 4.76 ± 0.79 ml for the 3rd type of soil and 5.75 ± 1.80 ml for the 2nd type of soil (mean ± SD).

The average quantity of fuel needed for digging a hole up to 30 cm: 4.31 ml for the 1st type of soil, 5.75 ml for the 2nd type of soil, 4.76 ml for the 3rd type of soil and 3.49 for the 4th type of soil.

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AGROCHEMICAL CHARACTERISTICS AND FERTILITY OF THE ALLUVIAL IRRIGATED SOILS OF UKRAINE AND MOLDOVA

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Abstract

The parameters of the agrochemical state and fertility of alluvial-meadow soils of the Dnieper and Dniester rivers have been studied. Irrigation of soils of the floodplain Dnieper river is characterized by a high degree of fertility of the 0-20 cm layer: a high content of humus, nitrogen, phosphorus and potassium (according to the National Standards of Ukraine). In the profile distribution of humus content in the non-irrigated soil, there are two peaks: the sod and the buried humus horizon. The content of nutrients from the sod to depth on the profile of the non-irrigated soil is sharply reduced. Alluvial irrigated soils in the Dniester meadow are characterized by low humus content in dependence on the soil clay texture, high content of mobile phosphorus and exchangeable potassium in the arable layer. In the deeper horizons of the all studied soils, the content of nutrients and humus sharply decreases. To increase the fertility of irrigated agricultural soils it is necessary to increase the flow of organic matter into the arable layer by using them under multi-annual grasses.

***Key words**: alluvial soil, irrigated soil, fertility, meadow, profile.*

INTRODUCTION

The river beds (meadow) are the geomorphological bases of the drainage basins. In the process of evolution, the meadows are subjected to different processes, conditioned by the river regime and the hydrographical processes within the drainage basin. The processes of meadow formation are very complicated and lead to the creation of large variables of alluvial soils (alluvisoils) on different segments of meadows. The variability of alluvisoils is complicated not only by the alluvial processes, but also by the local peculiarities of the water regime of the meadow, the quality of the groundwaters etc. All these local and dynamic particularities contribute to the formation of alluvisoils variability in the river beds. Depending on the length of the river and the dimensions of the meadow, alluvisoils with different morphological structures, substantial composition, hydrological regimes, salinization degrees are formed on different segments (Думих, 2016).

Alluvial soils belong to the class of soils, their composition and properties being subjected and conditioned by different current processes. Alluvial soils are intrazonal formations, as the transitional river beds pass through different natural areas and pedogeographic units (Ursu et al., 2012).

In recent years, the United Nations Food and Agriculture Organization (FAO) has set the soils as world's most important priority for food security (Revised World Soil Charter ..., 2015). Under conditions of soil cover degradation and global warming, food security can be ensured only by expanding of irrigated soils.

Irrigation is a powerful impact factor on the soils. The introduction of additional moisture in the soil determines the transformation of the organic and mineral constituents of soils (Балюк, 2009). It is known that the direction and intensity of soil processes is determined by the quality of irrigation water, climatic and hydrogeological conditions of the regions, relief, buffer properties of soils, irrigation technology and crop culture (Балюк, 2013).

The most suitable areas for development of irrigated agriculture are fields and meadows with alluvial soils non-salinzated and non-solonetzizated.

On the territory of Moldova, within the agricultural land, the alluvial soils occupy the area of about 117 thousand hectares and are the main object for the development of irrigated agriculture. In this case, a major interest for the extension of the irrigated agriculture is the alluvial soils from the Dniester meadow.

Among the irrigated lands in Ukraine there are about 350 thousand hectares of saline, of which 70-100 thousand hectares of secondarily saline soils.

The area of solonetzic soils is 2.8 million hectares (mainly within the Steppe), about 2/3 of them are ruined, and about 0.8 million hectares are irrigated (Балюк, 2012).

The alluvisoils, due to the extremely different conditions regarding the duration of the solification, the climate of the area, the origin of the fluvial deposits, their texture and composition, the depth and mineralization of the groundwater, are characterized by a great variation of properties and composition. Irrigation acts differently on the quality of alluvial soil varieties.

The aim of the research is to identify changes in agrochemical properties and fertility of alluvial soils in the Dniester and Dnieper meadows influenced by irrigation.

MATERIALS AND METHODS

Field survey of irrigated lands of the lower reaches of the Dnieper (Ukraine, Kherson region) and Dniester (Moldova, Kaushani district) was conducted using the analogy-key method on the polygons.

In the investigation area, the key sites and polygons have been laid on irrigated and non-irrigated soils. Within the sites laid down by the soil section and wells to the depth of groundwater (1-2 m). Mixed soil samples from each genetic horizon were selected from each section and well.

Selection, preparation for analysis and preliminary processing of soil samples of the lower reaches of the Dnieper and Dniester, subjected to agrochemical analysis, were carried out according to the normative documents and methods existing in Ukraine and Moldova (Soils quality: 2002, 2004a, 2004b, 2007a, 2007b).

The investigated irrigated soil (Ukraine) is alluvial sod soil, used for a long time in organic farming, drip irrigation (20 years) and vegetable crop rotation (Figure 1). Non-irrigated variant is alluvial meadow soil (virgin), used in agricultural production as pasture.

Figure 1. Alluvial irrigated soil of Lower Dnieper meadow

In the profile of irrigated soil, horizons have been identified: as arable, transitional and rock-wet, loose, sandy. Groundwater-deeper than 1 m. In non-irrigated soil, another structure of the soil profile was noted - horizons were distinguished: sod, humus gleyied, transitional, transitional gleyeid, rock. From the depth of 9 cm the soil is moist, and from 85 cm and deeper-groundwater.

Investigated irrigated alluvisoils of Moldova are widespread in the meadow beneath the terraces of the Lower Dniester on the territory of Kopanca commune in Kausheni district, and as well in other communes in the southern districts of Moldova, especially in the last 30 years. At present, irrigation of alluvisoils on the territory of Kopanca commune is carried out by sprinkling with a Fregat type irrigation plant.

The researched territory, until the irrigation landscaping works were done, was swamping and often affected by the overflowing of the Dniester river. In 1985 a dam was built, which avoids the overflowing of this land and an efficient drainage-drying system of the Lower Dniester meadow on the Kopanca territory. At present, this drainage system provides the permanent groundwater level deeper than 2 m from the terrestrial surface.

The irrigated and investigated alluvial soils from the Lower Dniester meadow are characterized by the following types: *Ahp1 (0-20 cm)→ Ahp2 (20-38 cm)→ ABh (38-57 cm)→ Bhg (57-80 cm)→ Abhg (80-95 cm)→ Bbhgk (95-115 cm)→ Gk1 (115-135 cm)→ G2 (135-160 cm)→ G3 (160-200 cm)* (Figure 2).

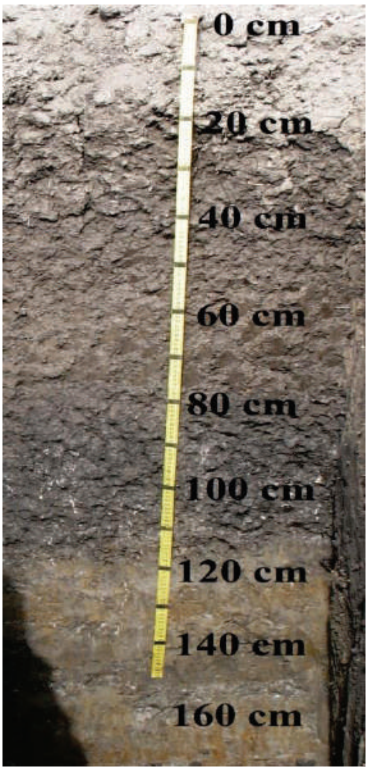

Figure 2. Alluvial irrigated soil of Lower Dniester meadow

RESULTS AND DISCUSSIONS

Alluvisoils of Lower Dnieper meadow

Alluvial sod soil of the lower reaches of the Dnieper river, which is used for growing vegetable crops under conditions of drip irrigation, is characterized by a high degree of cultivation in the 0-20 cm. This layer contains more than 4 percent of humus (Figure 3), which is a high index for such soils and is characterized by an increased content of mineral nitrogen, very high content - mobile phosphorus and moderate - exchangeable potassium (according to Chirikov method).

The arable horizon of a given soil is no longer just a layer of soil that is being processed. In fact, this is a new genetic horizon with a specific structure, properties, ecological functions with respect to modes of perception of moisture, emission, metabolism and energy.

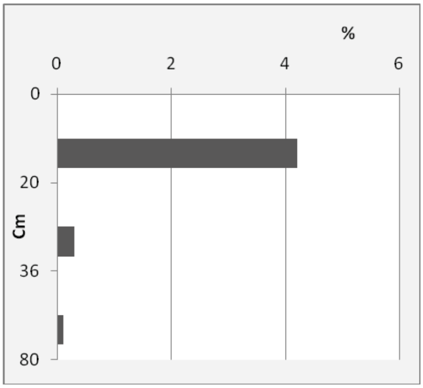

Figure 3. Content and profile distribution of humus in irrigated soil of the Dnieper river floodplain, %

The deeper horizons of this soil, subjected to much less influence of acculturation, have parameters typical for such soils formed on sands of alluvial origin. In the transitional horizon of this soil (20-36 cm) and deeper, the content of humus and mineral nitrogen is very low, phosphorus is medium and decreases to low, and potassium content is low.

The profile of alluvial meadow soil has significant differences in structure and agrochemical characteristics. Sandy loam with a thickness of about 10 cm has a very high humus content (Figure 4) and mineral nitrogen, increased content of phosphorus and medium content of potassium.

The humus horizon (10-25 cm) is characterized by a low content of humus, a very low level of availability with mineral nitrogen, medium - phosphorus and low - potassium.
In the first transition horizon (25-44 cm), there is practically no organic matter, very low content of mineral nitrogen, medium for phosphorus and low - potassium.

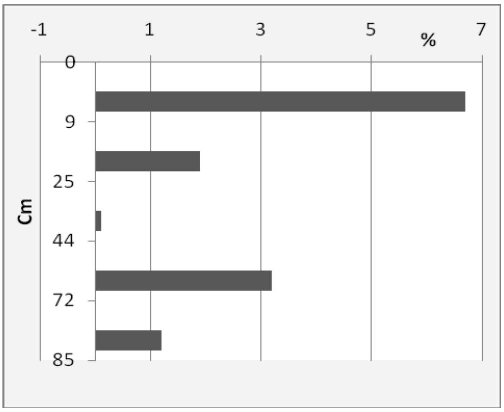

Figure 4. Content and profile distribution of humus in non-irrigated soil of the Dnieper river floodplain, %

The second transition horizon (44-72 cm) has an increased humus content, is characterized by a low level of mineral nitrogen, medium - for mobile phosphorus and potassium. It is actually a long-standing (ancient) humus horizon, buried beneath sandy alluvial sediments. Deeper in the profile, the content of humus, nitrogen, phosphorus and potassium decreases.
The studies did not reveal a statistically proven negative effect of irrigation on the humus state of soils and the content of nutrients in them. Such data indicate a significant reserve of nutrients in soils and the need to take measures to conserve organic matter.
A greater influence on the differentiation of the soil cover and its fertility is caused by the diversity of the geomorphologic - lithological characteristics of small areas of the floodplains of large rivers, which caused the differences in the agrochemical characteristics of alluvial soils under study.
The investigated soils distributed in the lower reaches of the Dnieper river quite clearly reflect the conditions of their formation: a shallow level of fresh surface water of 1-2 m, which ensures a constant moistening of the soil throughout the depth of the profile, short-term flooding, remoteness from the river bed.
Non-irrigated soil, more closely approximated to the bed of the river, is characterized by stratification of the profile and presence of the humus horizon buried by the alluvium sediments. Irrigated soil is located a little further (20 m) from the river bed. Its profile is more cultivated.
Of concern occurrence is the level of groundwater on the irrigated land - it is close to 1 m from the surface. This is less than the critical depth that threatens flooding, salinize-tion and alkalinization of irrigated lands and requires the use of artificial engineering drainage and a set of appropriate agro-amelio-rative and agro-technical measures.
The soil cover of the river floodplains, even relatively small areas, is complex and diverse in morphogenetic structure, composition and properties. Specificity and variegation of the soil cover of the floodplains of large rivers as Dnieper and Dniester necessitates a clear differentiation of the methods and technologies of using these lands, the normalization of anthropogenic loads on them.

Alluvisoils of Lower Dniester meadow

Regarding to the provenance of the alluvial irrigated soil profile by sedimentation of the alluvial deposits, the layered stratification of their profile in space and in depth is very variable. The profile of the studied soils is less differentiated in the upper horizons and is characterized by buried soils and gleyic horizons in the lower part. This is due to the fact that in the part under the terrace of the meadow, the overflows were rare, and after the construction of the dykes they were stopped.
Differentiation in more or less regular genetic horizons is only observed up to a depth of 80 cm. In the depth range of 80-95 cm there is a humid horizon Abhg, formed in another historical period. Under this horizon there is an extremely pronounced gleyic horizon with thin humic layers. So, the profile of the studied soil is composed of the buried gleyic soil, very humid, situated at the depth of 80-200 cm; and the contemporary soil with humiferous developed profile, poorly gleyic in the lower part, situated in the depth range of 0-80 cm.
The average pH values on the studied soils are basically analogous: 8.0-8.1 ± 0.3. The reaction

of the soil solution is slightly alkaline. The accuracy of the average pH indices is 1.6-2.1%. Parameters of this index are characterized by a small variation in space (V=3.2-4.3%).
The average humus content in the irrigated soil profile ranges from 2.98% ± 0.45% in the arable layer to 2.27% ± 0.49% in the underlying Bhg layer. In the buried soil the humus content ranges from 2.69% ± 0.31% in the Abhg horizon to 2.18% ± 0.32% in the Bbhgk horizon. The humus content in the gleyic horizons varies within the range of 1.01-1.31%, due to the existence of thin humic layers that practically imbibes these horizons with them (Table 1).

Table 1. Physic-chemical properties (average) of the irrigated alluvial soil of the Dniester river floodplain

Horizon and depth	pH (H_2O)	$CaCO_3$ %	Humus, %	C : N
Ahp1 (0-20 cm)	8.0	2.6	2.98	10.7
Ahp2 (20-38 cm)	8.0	3.2	2.71	10.3
ABh (38-58 cm)	8.1	3.6	2.51	9.8
Bhg (58-79 cm)	8.1	2.3	2.27	-
Abhg (79-95 cm)	8.1	1.4	2.69	-
Bbhgk (95-111 cm)	8.0	1.2	2.18	-

After the humus content in the arable layer the studied soils are submoderate to moderately humiferous, which is absolutely unjustified for soils with fine clayey texture (Figure 5).

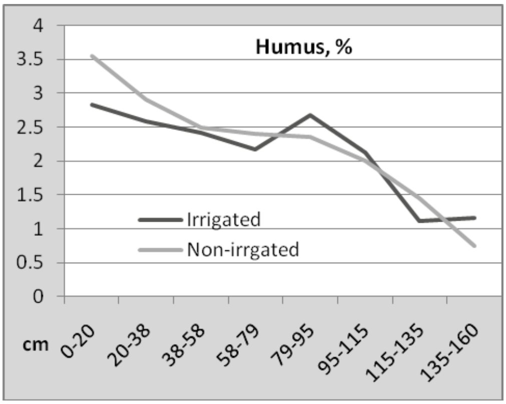

Figure 5. Humus in alluvisoils, irrigated and non-irrigated (Dniester meadow)

The mobile forms of P_2O_5 content is 9.7 ± 1.2 mg/100 g in the recent arable layer and 8.5 ± 1.3 mg/100 g in the ABh horizon.
According to the mobile phosphorus content, the investigated soil falls within the category of those with very high insurance of this element.
The content of mobile forms of K_2O in the studied soils ranges from 35.5 ± 1.8 mg/100 g of soil in the arable layer to 27 ± 1.4 mg/100 g of soil in the ABh horizon (Table 2).

Table 2. The content (average) of nutrients in irrigated alluvial soil of the Dniester River floodplain

Horizon and depth	Mobile forms, mg/100 g soil		
	$P_2 O_5$	K_2O	$N\text{-}NO_3$
Ahp1 (0-20 cm)	9.67	35	0.287
Ahp2 (20-38 cm)	9.57	31	0.270
ABh (38-58 cm)	8.47	27	0.244

The content of mobile forms of K_2O in the studied soils ranges from 35.5 ± 1.8 mg/100 g of soil in the arable layer to 27 ± 1.4 mg/100 g of soil in the ABh horizon (Table 2).
According to the mobile potassium content the soil falls into the category of high insurance in this element (Cerbari, 2016).
The non-irrigated soils from the Lower Dniester meadow are characterized by a higher humus content in the 0-18 cm layer (3.15%). In depth, the humus content does not differ from that in irrigated soils.
The content of mobile forms in non-irrigated soils are: P_2O_5-11.00 mg/100 g of soil, K_2O - 50 mg/100 g, $N\text{-}NO_3$-0.560 mg/100 g.
On average, the mobile forms of nutrients represent an increase of 14% for phosphorus, 43% for potassium and 95% for nitrogen in the non-irrigated grasses soil layer compared to the irrigated arable layer.
The content of the mobile forms elements in the depth of the profiles does not differ.
Due to the clay texture, the low humus content, the unsatisfactory state of physical quality of the arable layer, these soils are a difficult object for irrigation use.

CONCLUSIONS

Irrigated soil of the flood plain of the Dnieper River is characterized by a high degree of cultivation of the 0-20 cm layer: high content of humus, nitrogen, phosphorus and potassium (according to the Standards of Ukraine).

In the deeper horizons of the soil, the content of nutrients and humus sharply decreases.

The upper horizon of the irrigated soil is also characterized by highly fertility indicators.

In the profile distribution of humus content in non-irrigated soil, two peaks are revealed: the sod and the buried humus horizon.

The content of nutrients from the sod deep into the profile of the non-irrigated soil is sharply reduced.

The level of occurrence of groundwater on irrigated land is of concern - it is close to 1 m from the surface.

The clay alluvial soils (irrigate and non-irrigated) from the lower Dniester River meadow are characterized by the following characteristics:

• layered profile with swamp clayey gleyic (fossil) burial soil at a depth of about 80 cm;

• contemporary soil with a thickness of 80 cm is characterized by homogeneous texture and developed humiferous profile, differentiated in genetic horizons;

• texture is clayey on the profile of the contemporary soil (up to about 80 cm deep) and fine clayey on the profile of the buried soil;

• good arable layer structure as a result of soil tillage, frost and thaw in the winter period;

• the underlying post-arable layer is characterized by unsatisfactory massive structure as a result of dehumification, destructuring and loss of compaction resistance;

• the high hygroscopicity values (9-10% in contemporary soil and 11-12% in buried soil) indicate large amount of wilting coefficient (large water reserves not accessible to plants);

• low profile carbonates (1-3%) and low alkaline reaction (pH 8.0-8.1) ensure normal growth of crop plants;

• the humic submoderate profile of the contemporary and buried soil;

• the high cationic exchange capacity of layers and horizons as a result of finely agglomerated and clayey texture ensures good adsorption of nutrients;

• the moderate content of the nitrogen content in the arable layer and small content in the underlying horizon is the result of the accelerated dehumification of these soils in arable and irrigation utilization rates;

• the high content of phosphorus (8.5-9.7 mg/100 g of soil) and mobile potassium in the soil totally assures the needs of crop plants in these elements.

The main measure of remediation of the quality of irrigated clay alluvisoils is the increase of the flow of organic matter into the arable layer and the restoration of the favorable structure.

ACKNOWLEDGEMENTS

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BIOCHEMICAL FEATURES OF *OPAQUE-2* GENE EXPRESSION IN THE TETRAPLOID MAIZE GRAINS

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Abstract

The purpose of the research was to study the expression of the opaque-2 (o2) gene in the tetraploid genome of maize by the biochemical characteristics determining the protein quality and the nutritional value of grains. Diploid and tetraploid populations of maize containing the o2 gene, created at the State Agrarian University of Moldova, were used as research objects. Tetraploids showed an increase in the content of "lysine in the protein" of the endosperm by 7-12%. Several populations were identified, which combine a high level of accumulation of protein and lysine in the dry matter of grain and the content of "lysine in protein". The biochemical parameters determining the nutritional and energy value of corn grain did not change significantly. The obtained tetraploid forms of maize with the o2 gene can be recommended as models for a more in-depth study of the expression of monogenic mutations in the polyploid genome.

Key words: *maize, diploid, tetraploid, opaque-2 gene, biochemical indices.*

INTRODUCTION

It is generally recognized that polyploidy is one of the most promising synthetic breeding methods (Lutkov, 1966).

According to Udall and Wendel (2006), polyploidy provides genome buffering, increases allelic diversity and heterozygosity and allows the generation of new phenotypic variations.

However, for the purposeful use of polyploidy in combination with mutagenesis, it is important to focus on the features of the expression of a particular gene (or complex of genes) in the polyploid genome.

The analysis of literature data shows that the maize crop (*Zea mays* L.) with the gene *opaque-2* (*o2*) is one of the unique model objects for discussing the formulated problem (Palii and Batiru, 2011).

More than half a century of experience in studies of o2 gene expression in diploid maize genomes testifies to the effectiveness of the biochemical approach to the study of the specificity of o2 gene expression, which causes significant changes in the synthesis of protein - the first product of the gene action (Plotnikov, 2005; Palii, 2008), characterized by a significant improvement in the balance of some essential amino acids (primarily lysine). It has been experimentally demonstrated that the nutritional value of diploid high-lysine forms, determined by significant changes in the biochemical composition of corn grain, is substantially improved (Rotari, 2013).

The logical connection between the comparative analysis of diploid and tetraploid forms of maize (Ellis et al., 1946) allows us to continue the study of the *o2* gene expression in the tetraploid genome and, primarily, by the biochemical characteristics determining the protein quality and the nutritional value of corn grain, which was the main task of the presented work.

MATERIALS AND METHODS

The populations of tetraploid maize with the *o2* gene, which were created at the Department of Plant Biology of the State Agrarian University of Moldova, were used as research objects.

The basis for the creation of these populations was the regionalized hybrids of the Moldavian breeding, improved in biochemical quality: 1) Chișiniovschi 307 PL hybrid - its genome is the carrier of the highly-lysine *o2* gene combined with the specificity of polygenic control of the increase in synthesis of the maize grain storage protein; 2) hybrid Chişiniovschi 401 L - for its creation, the *o2* gene was also used.

It was these hybrids that were transferred to the tetraploid level by the method of colchicination (Palii and Batiru, 2011).
The method of Yudin was used (1964) to accelerate the process of creating tetraploid populations with the *o2* gene.
This method allowed already in the first year of reproduction to obtain tetraploid hybrids with the *o2* gene as a result of artificial intrapopulation pollination.
Place of reproduction of the experimental material: central zone of the Republic of Moldova (Cosernita village, Criuleni district). According to general meteorological conditions, the vegetation period of the experiment was characterized by the optimum for *Zea mays* L. crop. However, there was noted a water deficit in the critical phase for the reproduction of the maize plant (flowering and grain filling). This stress factor (due to lack of moisture) in the process of reproduction of diploid and tetraploid forms, caused a wide range of variation in the kernel set.

A

B

C

D

Figure 1. Visual variation of the kernel set of different genotypes of maize: A- diploid hybrid Chişiniovschi 307 PL (2x); B- tetraploid hybrid Chişiniovschi 307 PL (4x); C- tetraploid population SP 383 (4x); D- tetraploid population SP 461 (4x)

Figure 1 shows quite clearly the significant phenotypic differences in the kernel set between the diploid (2x) and tetraploid (4x) form of the hybrid Chişiniovschi 307 PL.
The revealed phenotypic specificity justified the need to select more homogeneous corn cobs for carrying out biochemical analysis (Figure 1, A, B).
At the same time, a visual analysis of the 12 tetraploid created populations (Figure 1, C, D) indicated the possibility of selecting the samples with similar elements of yield structure (cob length, rows and number of grains in the cob) for a more objective biochemical parameters comparison between tetraploid and diploid corn forms.
Such a thorough approach to sampling for studying the biochemical characteristics of the grain with *o2* gene expression in the genome of tetraploid maize is due to the previously established regularity (Ellis et al., 1946; Batiru, 2014) of increasing the protein content in the grain of defective ears.

This specificity may be due to:
- the effect of moisture deficiency in the critical phases of generative and reproductive development of maize;
- abnormalities that occur in tetraploid forms at the cytogenetic level.

The analysis of diploid and tetraploid forms of maize was carried out according to the key metabolites of grain, which determine:

a) the expression of the *o2* gene on the main biochemical marker of this gene - the content of "lysine in protein" of the corresponding genotype under study, which provided for a biochemical assessment of the content of "crude protein" and "lysine" in absolutely dry matter of the grain;

b) expression of the *o2* gene by the main biochemical indicators of the nutritional value of corn grain: "crude protein", "crude fat", "crude fiber", "ash" and "nitrogen-free extractives (NFE)", and also the leading component of nitrogen-free extractives, which determines the energy value of grain, - the content of "starch".

The content of all listed metabolites was evaluated by Near Infrared Spectroscopy on the IR 4500 "Interagroteh" (Krishchenko, 1997), which was calibrated using standard classical methods for analyzing of the biochemical indicators studied (Rotari, 2013).

RESULTS AND DISCUSSIONS

In accordance with the task at the first stage of the experiments, a comparative analysis was made of the *o2* gene expression on the main biochemical marker of this mutation - the content of lysine - the essential amino acid in the prolamin fraction of the grain protein of diploid and tetraploid heterozygous genotypes of maize.

As the data in Table 1 show, the transfer of the Moldovan breeding hybrids: Chişiniovschi 307 PL and Chişiniovschi 401 L, to the tetraploid level, induces an increase in the dry matter of the grain the protein content by 4-6%, the lysine content by 12-18% and enhances biochemical marking of the *o2* gene expression by content "lysine in protein" in the tetraploid genome.

Table 1. Comparative analysis of the *opaque-2* gene expression in the grain of diploid and tetraploid forms of maize by the protein content and the essential amino acid - lysine

Nr.	Genotype, population	Ploidy	% dry matter		% lysine in protein (g/100 g)
			protein	lysine	
1	Ch.307 PL	2x	12.77	0.49	3.84
2	Ch.307 PL	4x	13.32	0.55	4.13
		Δ	+0.55	+0.06	+0.29
		Δ %	+4.32%	+12.24%	+7.55%
3	Ch.401 L	2x	12.22	0.33	2.70
4	Ch.401 L	4x	12.91	0.39	3.02
		Δ	+0.69	+0.06	+0.32
		Δ %	+5.64%	+18.18%	+11.85%

Moreover, the heterozygous genome of the hybrid Chişiniovschi 401 L transferred to the tetraploid level showed more significant changes in the protein metabolism of corn grain by the content of "lysine in protein" - by almost 12%, while in the genome of the hybrid Chişiniovschi 307 PL, as a result of colchicination, the *o2* gene expression by the content of "lysine in protein" only increased by 7.6%.

Probably, the revealed biochemical specificity for each of the analyzed hybrids is caused by genetic differences of the initial maize hybrids genomes of Moldavian breeding. The hybrid Chişiniovschi 401 L was created by traditional heterotic selection using only one monogeneity characteristic controlled by the *o2* gene, while the Chişiniovschi 307 PL hybrid was created on the basis of the introduction of the *o2* gene in combination with the germplasm of the high-protein forms of maize, i.e. its genome is characterized by a more significant genetic modification of the original complex of protein metabolites of corn grain.

A study of the variation in the biochemical parameters of *o2* gene expression among tetraploid populations obtained as a result of colchicination (Table 2) allows us to conclude that the coefficient of variation is characterized by a weak significance (V% = 4.32) by the content of "crude protein", but for the content of “lysine” in the dry matter of the grains of studied populations, the coefficient of variation is determined by the average significance (V%=11.61).

Table 2. Variation of the protein content and the essential amino acid - lysine - in the grain of tetraploid forms of maize with the *opaque-2* gene

Nr.	Genotype, population	Ploidy	% dry matter		%/100 g protein
			protein	lysine	lysine/protein
1	Ch.307 PL	2x	12.77	0.49	3.84
2	Ch.401 L	2x	12.22	0.33	2.70
	Average	*2x*	***12.50***	***0.41***	***3.27***
3	Ch.307 PL	4x	**13.32**	**0.55**	**4.13** *(Δ %+26%)
4	Ch.401 L	4x	**12.91**	0.39	3.02
5	C34	4x	13.33	0.49	***3.68***
6	SP 270	4x	12.67	0.41	3.24
7	SP 383	4x	**13.25**	**0.50**	3.77
8	SP 369	4x	12.77	0.48	3.76
9	SP 458	4x	**13.35**	**0.53**	**3.97** *(Δ %+21%)
10	SP 459	4x	**13.41**	**0.53**	**3.95** *(Δ %+21%)
11	SP 461	4x	12.41	0.39	3.14
12	SLG 2306	4x	**13.33**	0.49	***3.68***
13	SLG 3232	4x	**12.92**	0.47	***3.64***
14	SLG 3330	4x	**13.16**	**0.51**	**3.88** *(Δ %+19%)
15	SFA	4x	**13.77**	0.49	***3.56***
16	C34-181	4x	**12.91**	0.46	***3.56***
	min	4x	*12.41*	*0.39*	*3.02*
	max	4x	*14.77*	*0.55*	*4.13*
	V%		**4.32**	**11.61**	**9.97**

Table 3. Comparative analysis of the expression of the *opaque-2* gene in the grains of diploid and tetraploid forms of maize according to the content of biochemical parameters determining the nutritional and energy value

Nr.	Genotype, population	Ploidy	% dry matter					
			protein	lipids	cellulose	ash	NFE	starch
1	Ch.307 PL	2x	12.77	4.69	3.94	1.32	77.28	71.23
2	Ch.307 PL	4x	13.32	4.33	3.92	1.33	77.10	69.93
		Δ	+0.55	-0.36	- 0.02	+0.1	-0.18	-1.3
		Δ %	**+4.3%**	-7.7%	-0.5%	**+7.6%**	-0.2	**-1.8%**
3	Ch.401 L	2x	12.22	4.76	3.93	1.32	77.77	71.00
4	Ch.401 L	4x	12.91	4.79	3.91	1.33	77.06	69.33
		Δ	+0.69	+0.03	-0.02	+0.1	-0.71	-1.67
		Δ %	**+5.6%**	**+0.6%**	-0.5%	**+7.6%**	-0.9%	**-2.34%**

The variation coefficient of marker *o2* gene expression by content of "lysine in the protein" is on the border of weak and medium significance (V% = almost 10%).

The statistical analysis of the biochemical parameters variation allowed selecting three tetraploid forms from the analyzed samples: SP 458, SP 459 and SLG 3330. As follows from Table 2, these forms combine the high values of all the studied parameters of the protein complex: the content of "crude protein" and "lysine" in dry matter of tetraploid populations grain, as well as the parameter directly determining the biochemical effect of the *o2* gene - the content of "lysine in protein". The relative increase in the "lysine content in the protein" (*Δ% - Table 2) in the selected tetraploid populations in terms of the average value of this indicator in diploid high-lysine maize hybrids is 19-21%. However, the maximum increase in the content of "lysine in protein" (by 26%) is established in the tetraploid form obtained from the highly lysine high-protein hybrid Chişiniovschi 307 PL.

Table 4. Variation of the content of biochemical indicators determining the nutritional and energy value of grain of tetraploid forms of maize with the *opaque-2* gene

Nr.	Genotype, population	Ploidy	% dry matter					
			protein	lipids	cellulose	ash	NFE	starch
1	Ch.307 PL	2x	12.77	4.69	3.94	1.32	77.28	71.23
2	Ch.401 L	2x	12.22	4.76	3.93	1.32	77.77	71.00
	Average	***2x***	***12.49***	***4.72***	***3.94***	***1.32***	***77.52***	***71.12***
3	Ch.307 PL	4x	**13.32**	4.33	3.92	1.33	77.10	69.93
4	Ch.401 L	4x	**12.91**	**4.79**	3.91	1.33	77.06	69.33
5	C34	4x	**13.33**	3.75	**3.95**	1.31	77.66	70.28
6	SP 270	4x	12.67	4.51	3.94	1.32	77.56	70.94
7	SP 383	4x	**13.25**	4.57	3.93	1.33	77.00	70.34
8	SP 369	4x	12.77	4.45	**3.95**	1.31	77.52	71.03
9	SP 458	4x	**13.35**	4.58	3.93	1.33	76.81	70.45
10	SP 459	4x	**13.41**	4.40	3.93	1.33	76.93	70.09
11	SP 461	4x	12.41	4.19	**3.95**	1.32	78.13	70.51
12	SLG 2306	4x	**13.33**	4.38	3.93	1.32	77.04	70.55
13	SLG 3232	4x	**12.92**	4.27	3.94	1.32	77.55	70.43
14	SLG 3330	4x	**13.16**	4.66	3.92	1.33	76.93	70.44
15	SFA	4x	**13.77**	4.37	3.91	1.33	76.62	69.05
16	C34-181	4x	**12.91**	4.57	3.91	1.32	77.29	70.51
	min	4x	12.41	3.75	3.91	1.31	76.62	69.05
	max	4x	13.77	4.79	3.95	1.33	78.13	71.03
	V%		**4.32**	**5.66**	**0.37**	**0.56**	**0.53**	**0.77**

Discussion of the biochemical parameters characterizing the nutritional and energy value of diploid and tetraploid forms of maize allowed us to concentrate our attention on the analysis of the pleiotropic effect of the *o2* gene.

As the data of Table 3 show, in addition to the indicators of the content of "crude protein" and the content of "ash", it is impossible to establish the presence of significant differences between diploid and tetraploid forms of maize for one of the studied metabolites.

The pleiotropic effect of the *o2* gene on the "crude fat" content is largely dependent on the genotypic environment. There is also a certain tendency to decrease the content of biochemical indicators of the energy value of grain of tetraploid forms - both in the content of "nitrogen-free extractives" and in the content of "starch". However, the observed differences are no more than 2% (in relative values).

The statistical calculation of the coefficients of variation of the biochemical indicators of nutritional and energy values under discussion (Table 4) allows us to establish a variation with weak significance for each of the studied parameters.

The tetraploid population SP 461 is of some interest for a more in-depth study of nutritional and energy value, which requires the use of methods that go beyond biochemical studies.

CONCLUSIONS

The transfer of the heterozygous maize genome with the *o2* gene to the tetraploid level induces an increase in the content of "lysine in the protein" of the endosperm by 7-12%, depending on the level of genetic modification of the initial complex of protein metabolites.

Among the tetraploid forms of maize created by colchicination, three populations have been identified: SP 458, SP 459 and SLG 3330, that combine a high level of accumulation of the studied indices of the protein complex: “protein” and “lysine” content in the dry matter of grain and the content of "lysine in protein".

The pleiotropic effect of the *o2* gene on the tetraploid level did not significantly change (with the exception of the "crude protein") the quantitative characteristics of biochemical parameters determining the nutritional and energy value of corn grain.

The obtained tetraploid forms of maize with the *o2* gene can be recommended as models for a more in-depth study of the expression of monogenic mutations in the polyploid genome.

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SUNFLOWER BIOMASS YIELD AT DIFFERENT ROW SPACING AND NITROGEN FERTILISATION CONDITIONS

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Abstract

Sunflower is one of the most important crops in Romania, being cultivated on about one million hectares in the last years. Apart producing the seeds for oil production, sunflower is also one of the most important melliferous plants, providing important quantities of honey. But, in addition to the above mentioned consecrated uses, sunflower crop could be an important source of biomass, which can be used as raw material for biogas production. From this perspective, the aim of this study was to evaluate the influence of the row spacing and the nitrogen fertilisation conditions on the biomass yield at the sunflower crop. For accomplishing this aim, a field experiment was performed in 2016 in the specific growing conditions from South Romania (44^{o}29' N latitude and 26^{o}15' E longitude), respectively at Moara Domnească Experimental Farm belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest. Four sunflower hybrids (Performer, Pro 144, P64LE19, and LG56.62) were studied at two row spacing (50 cm and 70 cm) and four nitrogen fertilisation conditions (0 kg.ha^{-1}, 50 kg.ha^{-1}, 100 kg.ha^{-1}, and 50 + 50 kg.ha^{-1}). The biomass determinations were performed in the early dough - dough plant growth stage. The obtained results showed that in the more favorable growing conditions represented by a better nitrogen supply through a nitrogen rate of 100 kg.ha^{-1} whether that was administrated in one application or in two applications of 50 kg.ha^{-1}, the dry biomass yields were higher at wide row spacing (70 cm between rows) then at narrow row spacing (50 cm). In the contrary, in less favorable growing conditions represented by no nitrogen application and nitrogen rate of 50 kg.ha^{-1}, the dry biomass yields were higher at narrow row spacing (50 cm between rows) then at wide row spacing (70 cm between rows).

Key words*: sunflower, dry biomass yield, row spacing, nitrogen fertilisation.*

INTRODUCTION

Sunflower is one of the most important crops in Romania, being cultivated on about one million hectares in the last years and ranking the third place as cultivated surface. Apart producing the seeds for oil production, sunflower is also one of the most important melliferous plants, providing important quantities of honey and being considered the most important melliferous crop. But, in addition to the above mentioned consecrated uses, sunflower crop could be an important source of biomass, which can be used as raw material for biogas production. From this perspective, the aim of this study was to evaluate the influence of the row spacing and the nitrogen fertilisation conditions on the biomass yield at the sunflower crop.

Growing biomass is among the cheapest options for CO_2 emissions reduction, particularly if that biomass is used for energy production (Roman et al., 1998).

Energy crops for biogas production need to be grown in sustainable crop rotations (Amon et al., 2007; Hahn and Ganssmann, 2008). Sunflower (*Helianthus annuus* L.) can be part of the energy crop rotations, respectively it can be included into the structure of the energy crops that could be used for biomass production (Dicu et al., 2016).

Sunflower could be characterised as being a crop tolerating the drought and succeeding under limited input conditions (Ion et al., 2015). In fact, sunflower is a temperate zone crop, which can perform well under a variety of climatic and soil conditions (Canavar et al., 2010). Moreover, sunflower fits well into various cropping systems (Pattanayak et al., 2016).

One of the important conditions to produce biomass in an efficient way is to use the most appropriate cultivation techniques (Balodis et al., 2011; Beg et al., 2007). In fact, studying the effect of different technological conditions, such as row spacing and nitrogen fertilisation, on the potential biomass yield that could be obtained at sunflower crop is of interest and importance for farmers growing sunflower for biomass production. But, research is needed to determine the best agricultural practices, which are targeted at maximizing yield in the field (biomass/hectare) (Ziebell et al., 2013).

MATERIALS AND METHODS

Researches were performed in the year 2016, under rainfed conditions, in a field experiment located in South Romania, respectively within Moara Domnească Experimental Farm (44^{o}29’ N latitude and 26^{o}15’ E longitude), belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest.

The year 2016 can be characterised from a climatic point of view as being warmer and drier than normal years defined by the average multiannual values of the climatic elements. Thus, in the period April-August, the average temperature was of 20.1^{o}C, while the multiannual value is of 18.5^{o}C, and the sum of rainfall was of 284 mm, while the multiannual value is of 313.2 mm.

The soil from the experimental area is a reddish preluvosoil, with is characterised by a humus content of 2.2 - 2.8%, clay loam texture, and pH values of 6.2 - 6.6.

The field experiment consisted in sowing four sunflower hybrids (Performer, Pro 144, P64LE19, and LG56.62) at two row spacing (50 cm and 70 cm) and four nitrogen fertilisation conditions (0 kg.ha^{-1}, 50 kg.ha^{-1}, 100 kg.ha^{-1}, and 50 + 50 kg.ha^{-1}.

Nitrogen fertilisation was performed with ammonium nitrite (33.5% nitrogen content), which was applied immediately after sowing, on 1st of April 2016, except for the experimental variant N_{50+50} that consisted in applying half of nitrogen rate (50 kg.ha^{-1}) just after sowing and the other half in the growth stage of six leaves (BBCH code 16), on 27th of May 2016.

The field experiment was organised in split plots with 32 experimental variants (4 hybrids x 2 row spacing x 4 nitrogen fertilisations). Each experimental variant consisted in six lines with a length of 8 m.

The crop technology consisted in the followings:

- the preceding crop was maize;
- ploughing was performed on 30th of October 2015;
- one harrow work was performed on 18th of March 2016, this being followed by one combinator work performed on 28th of March 2016;
- sowing was performed by the help of a manual planter on 1st of April 2016;
- plant density was of 60,000 plants.ha^{-1};
- the weed control was performed by two manual hoeing.

For each experimental variant, the sunflower plants from one square meter were cut at soil level and they were weighed immediately in the field in view to be determined the fresh biomass yield expressed as above-ground biomass. One average sunflower plant for each experimental variant was taken into the laboratory where it was cut in small pieces and then dried in the oven at 80^{o}C for 24 hours in view to be determined the dry biomass yield.

The biomass determinations were performed in the early dough - dough plant growth stage taking into account that in the growth stage the sunflower biomass is of importance as raw material for biogas production. The obtained data were statistically processed using the analysis of variance (ANOVA).

RESULTS AND DISCUSSIONS

Application of nitrogen and increasing the nitrogen rate from 50 to 100 kg.ha^{-1} increased the dry biomass yield of sunflower, with differences statistically significant for the nitrogen rate of 50 kg.ha^{-1} and distinct significant for the nitrogen rate of 100 kg.ha^{-1} (Table 1).

Compared to the dry biomass yield obtained at the nitrogen rate of 100 kg.ha^{-1}, respectively 11.05 tons.ha^{-1}, the dry biomass yield obtained in the conditions of splitting the nitrogen rate of 100 kg.ha^{-1} in two applications of 50 kg.ha^{-1} was smaller, respectively 10.59 tons.ha^{-1}, but still with a difference statistically distinct significant compared to control variant, respectively the variant with no nitrogen application (Table 1). This situation was registered for the row spacing of 70 cm as well as for the row spacing of 50 cm (Table 2). The highest dry biomass yields were registered at row spacing of 70 cm and the nitrogen rate of 100 kg.ha^{-1} whether the nitrogen was administrated in one application or in two applications of 50 kg.ha^{-1}, the differences being very significant compared to control variant.

Table 1. The dry biomass yields obtained at sunflower in different nitrogen fertilization conditions

Nitrogen rate (kg.ha^{-1})	Dry biomass			
	Yield (tons.ha^{-1})	Difference		
		Kg.ha^{-1}	%	Significance
0	8.63	0	100	control
50	10.00	1.37	115.87	*
100	11.05	2.42	128.04	**
50 + 50	10.59	1.96	122.71	**

5% LSD 1.13 tons.ha^{-1}
1% LSD 1.65 tons.ha^{-1}
0.1 % LSD 2.47 tons.ha^{-1}

Table 2. The dry biomass yields obtained at sunflower in different row spacing and nitrogen fertilization conditions

Row spacing (cm)	Nitrogen rate (kg.ha^{-1})	Dry biomass yield (kg.ha^{-1})	Difference		
			kg.ha^{-1}	%	Significance
70	0	8.05	0	100	control
	50	9.70	1.65	120.50	*
	100	11.69	3.64	145.22	***
	50 + 50	11.02	2.97	136.89	***
50	0	9.21	1.16	114.41	
	50	10.30	2.25	127.95	**
	100	10.41	2.36	129.32	**
	50 + 50	10.16	2.11	126.21	**

5% LSD 1.39 kg.ha^{-1}
1% LSD 1.92 kg.ha^{-1}
0.1 % LSD 2.64 kg.ha^{-1}

The dry biomass yields were higher at the row spacing of 50 cm for control variant (the variant with no nitrogen application) and the variant with the nitrogen rate of 50 kg.ha^{-1}, while for the row spacing of 70 cm the dry biomass yields were higher for the variants with the nitrogen rate of 100 kg.ha^{-1}, whether that was administrated in one application or in two applications of 50 kg.ha^{-1} (Figure 1). These findings are according to those already reported by Ion et al. (2015) for the studied area, respectively for favourable growing conditions the dry biomass yield tends to be higher at wide row spacing (75 cm between rows), while for less favourable growing conditions the dry biomass yield tends to be higher at narrow rows (row spacing of 50 cm). In our case, favourable growing conditions means a better nitrogen supply by a nitrogen rate of 100 kg.ha^{-1} whether that was administrated in one application or in two applications of 50 kg.ha^{-1}, and less favourable growing conditions means no nitrogen application and a nitrogen rate of 50 kg.ha^{-1}. However, the average dry biomass yields obtained in the conditions of the two row spacing were quite close.

The sunflower biomass moisture content varied between 71 and 76%, according to the row spacing and nitrogen fertilization conditions (Figure 2).

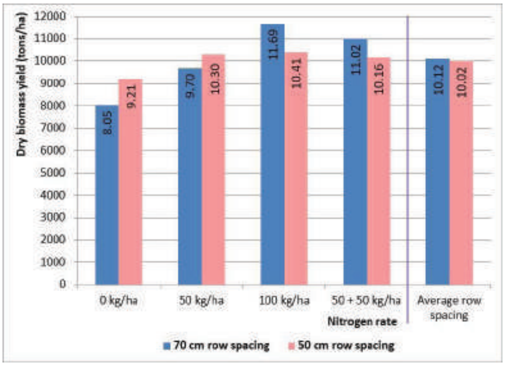

Figure 1. The dry biomass yields obtained at sunflower in different row spacing and nitrogen fertilization conditions

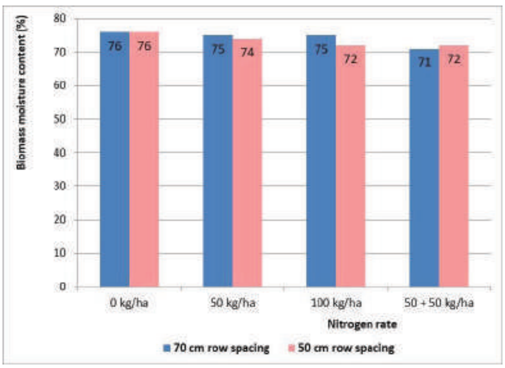

Figure 2. The sunflower biomass moisture content in different row spacing and nitrogen fertilization conditions

It has to be pointed out that the dry biomass yields obtained at sunflower in the climatic conditions of 2016 are smaller for the studied area, this year being characterised by higher temperatures and less rainfall compared to multiannual average values.

CONCLUSIONS

For the specific growing conditions, respectively on a reddish preluvosoil and in the climatic conditions of the year 2016 in South Romania, nitrogen fertilisation and increasing the nitrogen rate from 50 to 100 $kg.ha^{-1}$ increased the dry biomass yield of sunflower, with differences statistically significant for the nitrogen rate of 50 $kg.ha^{-1}$ and distinct significant for the nitrogen rate of 100 $kg.ha^{-1}$.

The obtained results showed that in the more favorable growing conditions represented by a better nitrogen supply through a nitrogen rate of 100 $kg.ha^{-1}$ whether that was administrated in one application or in two applications of 50 $kg.ha^{-1}$, the dry biomass yields were higher at wide row spacing (70 cm between rows) then at narrow row spacing (50 cm). In the contrary, in less favorable growing conditions represented by no nitrogen application and nitrogen rate of 50 $kg.ha^{-1}$, the dry biomass yields were higher at narrow row spacing (50 cm between rows) then at wide row spacing (70 cm between rows).

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THE FERTILIZERS INFLUENCE ON THE HARVEST AND THE QUALITY OF WINTER WHEAT ON THE CALCAREOUS CHERNOZEM UNDER THE AGROCLIMATE CONDITIONS OF THE 2011-2017 PERIOD

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Abstract

The atmospheric precipitation and the soil nutrient regime during 2011-2017 have significantly influenced the winter wheat productivity. The average precipitation rate was 263 mm in the vegetative rest period and 186 mm in the active one. The average harvest and the quality of the winter wheat on the non-fertilized variant constituted 2.13 t/ha, the content of wet gluten - 21.5% with the second quality group. The single fertilization with 120 kg N/ha on the moderate and optimal background of mobile phosphorus on the variant $N_{120}P_{2.5\text{-}3.5}K_{60}$ consisted 2.94-3.02 t/ha with wet gluten 28.8-29.8% - second quality group. The harvest increase was 38.0-41.6%, the gluten content increased by 7.3-8.3% versus the control variant. Nitrogen application in a maximum dose of 180 kg N/ha on the $P_{3.5}K_{60}$ background results in the highest harvest level of 3.07 t/ha or an increase of 44.1%, but fertilization with this dose contributes to the accumulation of nitrates in the lower layers of the soil. The optimal variant is considered the dose $N_{120}P_{2.5}K_{60}$ according to harvest obtained in the last seven agricultural years on the calcareous chernozem of Moldova.

***Key words**: fertilizers influence, harvest and quality, winter wheat, chernozem calcareous.*

INTRODUCTION

The territory of the Republic of Moldova, through its geographical location, falls within the area with insufficient and unstable humidity. The instability of agrometeorological conditions largely determines the variability and level of crop yields. Due to the improvement of agro-techniques and the implementation of new wheat varieties, the harvest of crops in years appreciated by the amount of moist and very damp precipitation, allows to obtain more than 5 tons per hectare of grains. This process is due to the development of the vegetal mass through the excessive consumption of nitrogen from the soil, and which does not allow the formation of the nitrogen bonds compared to the dry years (Ремесло, 1977).

To increase the productivity of winter wheat, chemical fertilizers play an important role. It is also proven in the works of D.I. Mendeleev, K.A. Timireazev, D.N. Prianishnicov, A.N. Lebedeantzeva, that the action of fertilizers can be investigated, only in the experimental field conditions. Field experience is the oldest and safest way to provide soil with nutrients to plant growth and development. However, it should be noted that fertilizers can contribute to doubling or tripling the production of straw cereals, such as wheat.

Applying one kilogram of active substance of fertilizer generates an average production yield of 10-15 kilograms of wheat grain. The optimal periods for wheat fertilization are determined by the stages of culture development, respectively at the end of the twinning - ear phase with the appearance of the first node, when the floral primordial differentiation occurs, the formation of the second node, the occurrence of the stamen and the formation of the grain formation in ear.

Plant fertilization in itself is one of the main conditions in their development and productivity. From the studies conducted in Moldova, the fertilizer requirements for winter wheat are 1: 3. According to the classical fertilization scheme, it is recommended to apply 0.05 tonnes per hectare of granulated superphosphate to the sowing of the culture, and 0.1 tonnes per hectare of ammonium nitrate for early spring feeding on the entire area sown with winter wheat. In this way of culture fertilization, we have the possibility to obtain from each ton of fertilizer at least 3.0 tons per hectare of winter wheat grains.

The effectiveness of chemical fertilizers shows a 22-25% increase in crop yields under the conditions of the Republic of Moldova (Дикусар, 1962).

MATERIALS AND METHODS

The studies were conducted at the Experimental Station for Pedology and Agrochemistry in the village of Grigorievca, Causeni district. The long-standing experience has been assembled by academician I. Dicusar and B. Tulcinskaia 56 years ago (Leah et al., 2013).

The experience was developed according to the block randomization method, consisting from 16 variants in 4 rehearsals for a field. The experience has been included in the international networks "European Soil Organic Matter" and "The Global Change and Terrestrial Ecosystems Soil Organic Matter Network".

The object of study was the calcareous chernozem, which aims the optimizing the nutritional regime for increasing the productivity of the main field crops. The data are presented for period 2011-2017 and indicate the level of crops and their quality in very strong drought agro-climatic conditions and wet years.

New data on the yield level of winter wheat was obtained based on the natural nutritional regime and the fertilizer system with mineral fertilizers at the calcareous chernozem. Also, the state and degree of change of the main production quality indices was determined depending on the level and the mineral fertilization system of the soil.

The agronomic efficacy of mineral fertilizers in field crops rotation was evaluated. Research has been carried out according to current methods: harvesting by harvest method, wet gluten of flour ground by washing method, gluten deformation index to IDK-1M and quality group after existing Standard 9353- 90.

RESULTS AND DISCUSSIONS

As much as the dependence between the harvest and the grain quality indices are obvious, we come to the conclusion that agro-meteorological factors have a direct influence on productivity. The researches carried out according to the pedoclimatic region of the southern area include the Causeni district in the third zone, with poorly wet and the highest temperature.

Annual rainfall ranges from 380 mm to 500 mm, during the vegetation period of 235-275 mm. For winter wheat with shorter period of vegetation the rainfall is 216 mm in the vegetative rest period and 153 mm in the active one, and over a year 478 mm.

The frequency of droughts is 70% in relatively dry years and 30-40% with varying degrees of drought. It has been established that 3-4 years out of 10 are considered droughts (Ursu, 2006).

Recent studies from 2011-2017 demonstrate the determinant role of rainfall on crop yield and quality of wheat (Table 1). The September-March months, which are considered to be the basis for high yields, indicate the 2012 year with moderate drought, 2011-2016 - wet, 2014-2017 - normal and only 2013-2015 - very damp. During the active vegetation period when the humidity consumption is increased and the extreme temperatures ≥30 degrees Celsius last for more than 10 days, the droughts occur.

Table 1. Appreciation of agricultural years by the amount of precipitation, Grigorievca Resort

Year	September - March		April - June		Agricultural Year	
	mm	Appreci-ation	mm	Appreci-ation	mm	Appreci-ation
2011	285	wet	274	very humid	559	wet
2012	194	moderate drought	70	very strong drought	264	strong drought
2013	318	very humid	209	Very humid	527	very humid
2014	211	normal	141	very strong drought	352	moderate drought
2015	333	very humid	109	very strong drought	442	normal
2016	272	wet	172	strong drought	444	normal
2017	231	normal	305	very humid	536	very humid
Average	**263**	**wet**	**183**	**normal**	**446**	**moderate humid**

The years 2012-2014 and 2015 were very strong dry (droughts) that decreased the harvest. The other three years were very damp.

As far as the general state of the agricultural years two years from seven are considered moderate and strong drought, two years - normal, one year - wet and one - very wet.

Fertilization of winter wheat on calcareous chernozem in the years 2011-2017 after the average sum of precipitations indicates in the variants $N_{120-180}P_{2.5-3.5}K_{60}$ where yields were 2.94-3.07 tons per hectare, the consumption of water by 42.5-46.9 mm was lower than the control variant (Table 2).

Table 2. Water consumption during winter wheat harvesting on carlcareous chernozem, average 2011-2017

Variant	Harvest	September-June atmospheric deposits (Q)	Qx 0.73	Water consum-ption	Compared to the control
	t/ha	mm	mm	mm/t	%
Control	2.13	446	326	153.1	100
$N_{120}P_{2.5}K_{60}$	2.94			110.9	72
$N_{180}P_{3.5}K_{60}$	3.07			106.2	69

Water consumption demonstrates a rational use of precipitation to form a tonne of grain by 28-31% less than the unfertilized variant. From the calculations the variant with the optimum water consumption of the winter wheat harvesting is $N_{120}P_{2.5}K_{60}$.

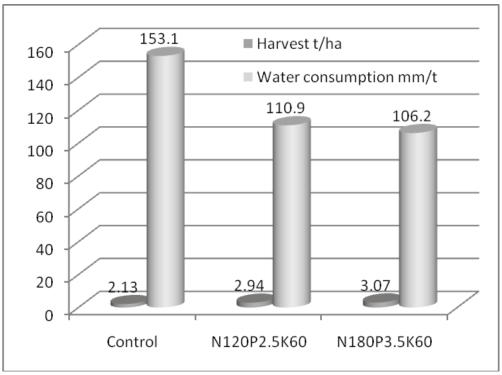

Figure 1. Dynamics of water consumption depending on wheat harvest

In the years 2005-2012 the average fertilizer standard applied in Moldovan agriculture was 25 kg/ha. From the total dose, about 90-95% are nitrogen fertilizers. Insufficient quantities of NPK - 27 kg/ha are applied to winter wheat, and obtain the 2.2 tonnes per hectare of grain. At present, the balance of nutrients in the soils of Moldova is profoundly negative NPK -132 kg/ha. As a result, accelerated chemical degradation of the soil occurs, with low yields and low quality (Andrieş, Leah et al., 2013).

The harvests of winter wheat show that the balance of nutrients decreases also on the calcareous chernozem. This was observed in the non-fertilized variant, where the yield in the last 7 years consists 2.13 t/ha.

Fertilization of winter wheat with chemical fertilizers increases harvest level in terms of nitrogen and phosphorus content in the soil. The application of the unique nitrogen dose of 120 kg/ha on low, moderate to high mobile phosphorus funds increased the yield from 2.60-2.94 t/ha to 3.03 t/ha. The average increase was 22.1-38.0% and increased to 42.3% on the fertilization variants. At the unfertilized nitrogen variant on the fund $P_{3.5}K_{60}$ the harvest was the lowest 2.44 t/ha or 14.6% (Table 3).

Table 3. Harvest of winter wheat on calcareous chernozem, average 2011-2017

Winter wheat				
N, kg/ha	P_2O_5, mg/100 g soil	K_2O, kg/ha	Harvest	Increase
			t/ha	%
Control			2.13	-
120	1.0	60	2.60	22.1
120	1.5	60	2.87	34.7
120	2.0	60	2.94	38.0
120	2.5	60	2.94	38.0
120	3.0	60	2.97	39.4
120	3.5	60	2.94	38.0
120	4.0	60	2.94	38.0
120	4.5	60	3.03	42.3
0	3.5	60	2.44	14.6
30	3.5	60	2.52	18.3
60	3.5	60	2.83	32.9
90	3.5	60	2.84	33.3
120	3.5	60	3.02	41.8
180	3.5	60	3.07	44.1

The minimum nitrogen dose on the optimal fund of mobile phosphorus - 3.5 P_2O_5 mg/100 g soil has insignificantly increased the yield level of 2.52 t/ha or by 18.3% according to Table 3. With the increase of the nitrogen dose from 60 kg N/ha to 180 kg N/ha on the optimal fund of phosphorus, the harvest level increases within limits: 2.83-3.07 t/ha or 32.9-44.1% (Figure 1).

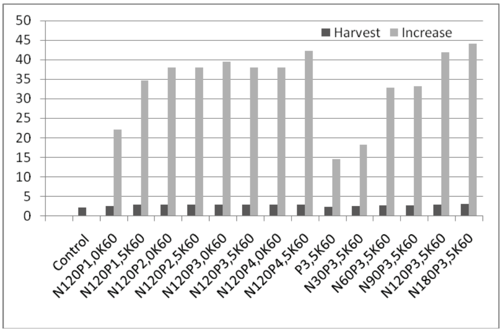

Figure 2. Dynamics of winter wheat crops according to fertilization levels

According to the Figure 2, the percentage of crop level oscillates to a great extent depending on the nitrogen dose, and the phosphorus does not act on it. The $N_{120}P_{2.0\text{-}2.5}K_{60}$ variant is considered to be optimal for winter wheat to harvest formation on calcareous chernozem.

The quality of winter wheat grains at the control variant consisted of 21.5% and increased up to 29.8% for the $N_{120}P_{3.5}K_{60}$ variant or 8.3% for the wet gluten content. Fertilization at a dose of 60 kg N/ha increased the gluten content by 4.3% (Table 4).

Table 4. Grain quality of winter wheat with different levels of fertilization, average 2011-2017

Variant	Calcareous Chernozem		
	Wet gluten content	IDG	Quality group
	%	units	
Control	21.5	86	II
$N_{60}P_{3.5}K_{60}$	25.8	88	II
$N_{120}P_{3.5}K_{60}$	29.8	84	II
$N_{180}P_{3.5}K_{60}$	28.6	87	II
$N_{120}P_{1.5}K_{60}$	28.3	91	II
$N_{120}P_{2.5}K_{60}$	28.8	91	II
$N_{120}P_{3.5}K_{60}$	27.3	96	II
$N_{120}P_{4.5}K_{60}$	26.3	97	II

The maximum dose of 180 kg N/ha increased the content of wheat gluten by 4.8% indicating a decrease in fact.

The optimal dose is considerate the $N_{120}P_{2.5}K_{60}$ variant with an average content of gluten - 28.8%. According to the deformation index the quality group of winter wheat grains at all variants is the second group (Table 4).

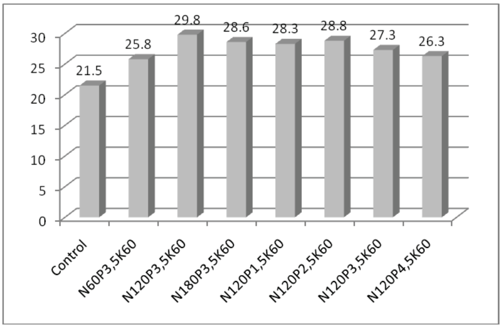

Figure 3. Dynamics of wet gluten content in winter wheat, average 2011-2017

According to the Figure 3, the gluten content increases only up to the 120 kg/N ha dose.

CONCLUSIONS

Recent studies carried out on the harvest and the quality of winter wheat in the years 2011-2017 on the calcareous chernozem, were depended by applying of the chemical fertilizers in different doses and zonal conditions of the Republic of Moldova.

The atmospheric precipitations that fallen unevenly (263-183 mm) during the period 2011-2017 contributed to the development and favorable growth of winter wheat.

The highest agronomic effect after water consumption was the $N_{120}P_{2.5}K_{60}$ variant, and was 110.9 mm/t. The harvest level increased by 0.81 t/ha, the percentage increase being 38.0% against the control, and the gluten content increased by 7.3%.

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THE YIELD PERFORMANCE OF VARIOUS SOYBEAN GENOTYPES IN FIVE EXPERIMENTAL FIELDS IN ROMANIA AND BULGARIA IN 2015 AND 2016

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Abstract

In the last four years, the continuous development of the soybean acreage in Europe, mostly in Central and Eastern Europe, is challenging farmers to apply the adequate growing technology in order to maximize the yields and increase the quality of soybeans. At the same time, this situation is creating a new momentum for breeders for new and/or improved soybean genotypes.
The yield performance of various soybean genotypes will allow breeders and agriculture experts to recommend farmers the right variety for a specific soybean cropping area and the farmers to select the right variety for obtaining the best yields under current soybean growing technology.
The field experiments were carried-out in 2015 and 2016 in different climate conditions, 2015 being considered less favorable for growing soybeans, while 2016 was favorable to very favorable for this crop.
A wide assortment of soybean varieties from different maturity groups created by public and private breeders for all-over Europe had been tested in two experimental years under different and regional specific conditions in five locations in Romania (Central, East, South-East and South-West) and one location in Bulgaria (North).

Key words: *experimental fields, maturity group, soybean genotypes, soybean growing technology, yields.*

INTRODUCTION

In the last four years, the continuous development of the soybean acreage in Europe, mostly in Central and Eastern Europe, is challenging farmers to apply the adequate growing technology in order to maximize the yields and increase the quality of soybeans.
At the same time, this situation is creating a new momentum for breeders for new and/or improved soybean genotypes.
The yield performance of various soybean genotypes will allow breeders and agriculture experts to recommend farmers the right variety for a specific soybean cropping area and the farmers to select the right variety for obtaining the best yields under current soybean growing technology.

MATERIALS AND METHODS

The scope of this paper was to bring information regarding the yield performance of various soybean genotypes into the attention of farmers and other interested parties.
A wide assortment of soybean varieties from different maturity groups created by public and private breeders for all-over Europe had been tested in 2015 and 2016 under different and regional specific conditions in five traditional soybean areas (Figure 1): The Agricultural Research and Development Station Turda in Central Romania; The Agricultural Research and Development Station Secuieni in East Romania; The Agricultural Research and Development Station Caracal in South-West Romania; private farm Agrichim Fetești in South-East Romania and in Bulgaria in one location at private farm ET Pris Borislav Goranov Knezha in North Bulgaria.
The field experiments were carried-out in two experimental years in different climate conditions, 2015 being considered less favorable for growing soybeans, while 2016 was favorable to very favorable for this crop.
In two experimental years at ARDS Turda were studied 63 soybean varieties, out of which 22 replicated each year. The seeding was done on April 21-28 at 50 cm between rows and 60 g.g./m^2 seeding density.
At ARDS Secuieni were tested 49 soybean varieties (27 replicated), seeded on April 25-27 at 50 cm between rows and 50 g.g./m^2 seeding density.

Figure 1. The locations of experimental fields in Romania and Bulgaria in the years 2015 and 2016

At ARDS Caracal were studied 43 soybean varieties (25 replicated), seeded on May 9-13 at 70 cm between rows and 55 g.g./m^2 seeding density. In Feteşti were tested 63 soybean varieties (24 replicated), seeded on April 14-28 at 37.5 cm between rows and 60 g.g./m^2 seeding density. In Knezha were studied 53 soybean varieties (17 replicated), seeded on April 18-19 at 70 cm between rows and 45 g.g./m^2 seeding density.

RESULTS AND DISCUSSIONS

In Turda, in 2015, the average yield per experiment was 2,104.2 kg/ha with variation limits from 1,442.0 to 2,668.0 kg/ha. A number of 40 soybean varieties had been tested, out of which 19 produced more that the average. In 2016 the average yield was 3,970.2 kg/ha (variation limits 3,040.0-4,910.0 kg/ha) and 28 varieties (out of 49 tested) produced more that the average (Figure 2).

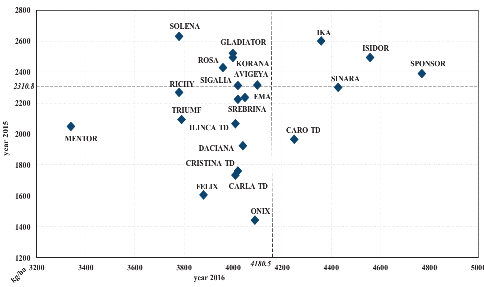

Figure 2. The yields obtained for the soybean varieties assortment (kg/ha, Turda, 2015-2016)

In Secuieni, in 2015, the average yield per experiment was 2,487.7 kg/ha (variation limits 1,463.0-3,388.0 kg/ha). An assortment of 36 soybean varieties had been studied, out of which 18 produced more that the average. In 2016, the number of tested varieties was 40 and 23 varieties had the yield above the average of 2,372.4 kg/ha (variation limits 1,522.0-3,677.0 kg/ha) (Figure 3).

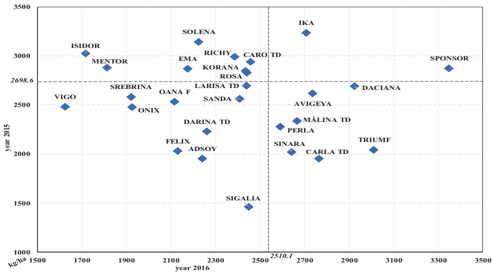

Figure 3. The yields obtained for the soybean varieties assortment (kg/ha, Secuieni, 2015-2016)

In Caracal, in 2015, was tested a number of 43 soybean varieties, out of which 22 produced more yield than the average of 2,792.7 kg/ha (variation limits 1,659.0-4,016.0 kg/ha). In 2016, were studied 41 varieties and the average yield of the experiment was 3,320.5 kg/ha (variation limits 2,753.0-4,716.0). 18 soybean varieties produced more then the average (Figure 4).

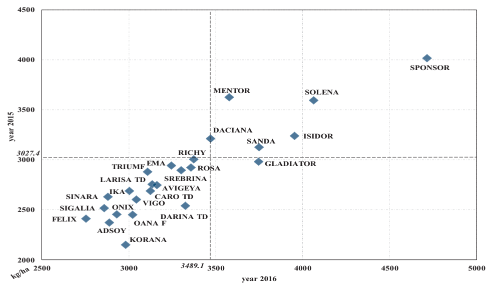

Figure 4. The yields obtained for the soybean varieties assortment (kg/ha, Caracal, 2015-2016)

In Feteşti, in 2015 were tested 42 soybean varieties that produced an average yield of 3,106.0 kg/ha (variation limits 2,200.0-3,550.0 kg/ha) and 25 varieties produced more that average. In 2016, the average yield was 3,015.4 kg/ha (variation limits 2,565.0-3,576.0 kg/ha) and 20 varieties (out of 43 tested) produced more that the average (Figure 5).

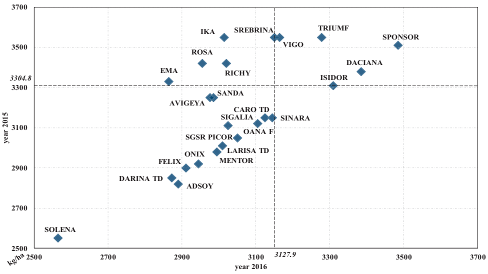

Figure 5. The yields obtained for the soybean varieties assortment (kg/ha, Fetești, 2015-2016)

At Knezha, in 2015, an assortment of 41 soybean varieties had been studied, out of which 23 produced more that the average (Figure 6).

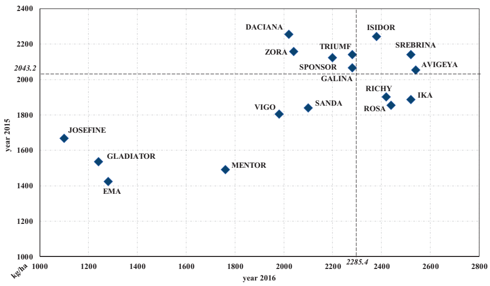

Figure 6. The yields obtained for the soybean varieties assortment (kg/ha, Knezha, 2015-2016)

In 2015, the average yield per experiment was 1,800.4 kg/ha (variation limits 945.0-2,314.0 kg/ha). In 2016, the number of tested varieties was 29 and 15 varieties had the yield above the average of 2,077.9 kg/ha (variation limits 1,100.0-2,980.0 kg/ha).

CONCLUSIONS

In the experiments from ARDS Turda, the soybean yields were greatly influenced by the weather conditions of the agricultural year. The most favorable year was 2016, when the average yield was 3,970.2 kg/ha and 27 varieties produced more than 4,000.0 kg/ha, while 2015 was less productive, with an average yield of 2,104.2 kg/ha and 5 varieties produced over 2,500.0 kg/ha. With average yields over two experimental years above 3,000.0 kg/ha can be mentioned the following soybean varieties: Caro TD, Ilinca TD, Sponsor, Isidor, Gladiator, Sigalia, Sinara, Solena, Ema, Ika, Korana, Avigeya, Rosa and Srebrina.

Under the conditions of ARDS Secuieni, the soybean varieties of the tested assortment produced between 1,463.0 and 3,388.0 kg/ha (2,487.7 kg/ha on average) in 2015 and between 1,522.0 and 3,677.0 kg/ha (an average of 2,372.4 kg/ha) in the year 2016. By comparison with average yields per year, 18 varieties produced more (out of which 14 varieties significantly exceeded the average) in 2015 and 21 varieties produced more (of which 13 varieties significantly exceeded the average) in 2016. Yields more than 2,500.0 kg/ha (average of two years) have been harvested from the following soybean varieties: Carla TD, Caro TD, Larisa TD, Mălina TD, Perla, Daciana, Triumf, Sponsor, Sigalia, Sinara, Ika, Avigeya and Rosa.

Under the experimental conditions of ARDS Caracal the soybean obtained high yields, ranging from 1,659.0 to 4,016.0 kg/ha, averaging 2,792.7 kg/ha in 2015 and between 3,320.5 and 4,716.0 kg/ha with an average of 3,320.5 kg/ha in 2016. Compared to average yields, 22 varieties produced more in 2015 and 18 varieties were above the average in 2016. More than 3,000.0 kg/ha average in two years have been obtained from the following soybean varieties: Daciana, Sponsor, Gladiator, Isidor, Mentor, Solena, Ema, Sanda, Richy, Rosa and Srebrina.

In the experiments from Agrichim Fetești, on fertile soil and under irrigation conditions, soybean yields were constantly high (3,015.4-3.106.0 kg/ha yearly averages). More than 3,000.0 kg/ha - average in two experimental years - were harvested from the following soybean varieties: Daciana, Triumf, Oana F, Caro TD, Larisa TD, Sponsor, Isidor, Sigalia, Sinara, Ema, Ika, Sanda, SGSR Picor, Avigeya, Richy, Rosa, Srebrina and Vigo.

Under the conditions of ET Pris Borislav Goranov Knezha, compared with average annual yields per experiment, 23 varieties produced more in 2015 and 15 varieties were above average in 2016. The soybean varieties that produced more than 2000 kg/ha are the following: Daciana, Triumf, Sponsor, Isidor, Avigeya, Richy, Rosa, Srebrina, Ika, Sanda, Galina and Zora.

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DETERMINATION OF SEPARATING PERFORMANS OF NEW DESING THRESHING UNIT FOR SAGE

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Abstract

For many years, mechanization of harvesting and threshing has been successfully implemented for various crops and has been developed depending on technological progress. However, the processes of threshing, separating and cleaning of medicinal aromatic plants are carried out by conventional methods (by hand) after the products are dried. This case leads to damage in the product, loss of labor and yield. In order to help to overcome these disadvantages and separate the dried products from the foreign materials such as stalk, spall and dust special separating systems designed depending on the plant are needed.

In this study, the separation-cleaning performances required for Sage (Salvia officinalis), for our country and the Mediterranean Region, have been determined. Performance values and working limits of the separating unit for sage (Salvia officinalis) have been determined. The separating unit is consisting of chassis, mainframe, two sieves, which have adjustable vibrating, velocity and inclination features, sieve housings, inclination adjusting mechanism and material outlet unit. The performance as separating efficiency, work efficiency and specific power consumption of separating unit were determined.

In order to determine the separation performances of the separating unit, 3 different sieves type experiments were performed depending on the amount of 3 different feedings. Experiments were carried out at 3 different sieve speeds and 3 different sieve slopes for sage. Each trial was performed in three replicates.

According to the study results, separating efficiency for sage (Salvia officinalis) used in the study changed between 41.44% and 97.89%. Work efficiency of separation unit changed between 0.69 kg/h and 6.00 kg/h. In different operations, specific power consumption of separation unit varied between 3.52 kW/kg and 30.06 kW/kg.

***Key words**: Sage (Salvia officinalis), separating, design, aromatic plant.*

INTRODUCTION

Sage plant (*Salvia officinalis* L.), one of the most characteristic aromatic plants of the Dalmatian karst, is a popular kitchen herb and member of the mint family (Generalić, 2012). It is used in cosmetics, perfume and medicine. (Tucker et al., 1980; Chalchat et al., 1988). It is also known as a great tonic for a number of ailments.

The importance of cultivation of medicinal and aromatic plants like sage plant has been increased due to the increasing demand for medicinal and aromatic plants in fields such as spices, beverages, perfumes and cosmetic industries as well as the pharmaceutical industry. (Anonymous, 2012).

It has been taken considerable steps about the medicinal-aromatic plant mechanization and different types of separating systems with the increasing demand for medicinal and aromatic plants used in harvesting and threshing machines.

Sieves and eccentrics moving the sieves are used in the separating system in parallel with the developing technologies.

The time of material on the sieves, sieve type, the amount of the material and the sieve inclination are important parameters for efficiency of separating (Kutzbach, 2003).

Harvesting, threshing, separating and cleaning medical aromatic plants is very important.

In recent years, numerous studies have carried out on sage plants, but work on the separating and cleaning system for this plant is limited.

In this study, being an important issue for medicinal and aromatic plant mechanization in our country and the Mediterranean Region, separation-cleaning unit performances required for Sage (*Salvia officinalis*) have been determined.

Performance values and working limits of the separating unit for sage (*Salvia officinalis*) specified. In order to determine the separation performances of the system separating efficiency, work efficiency and specific power consumption values have been designated.

MATERIALS AND METHODS

The specific separating unit designed for sage has been used during the performance experiments.

The separating unit consists of chassis, mainframe, two sieves, which have adjustable vibrating, velocity and inclination features, sieve housings, inclination adjusting mechanism and material outlet unit (Figure 1).

For this study, sage (*Salvia officinalis*) plants were harvested by hand from the experimental field in Suleyman Demirel University, Isparta, Turkey.

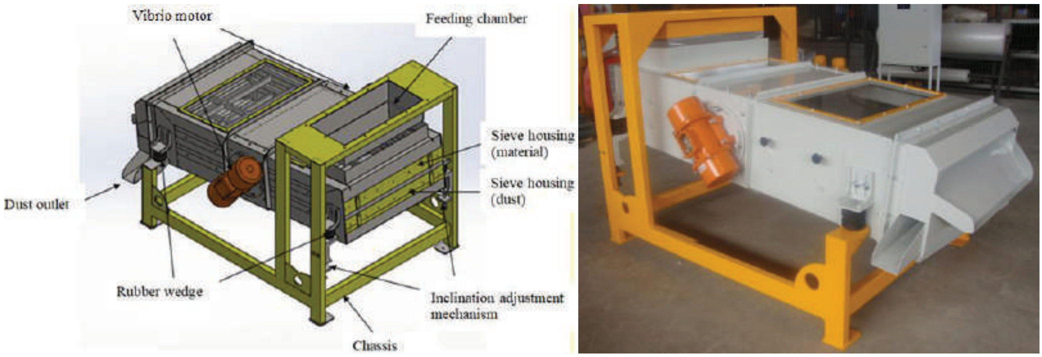


Figure 1. The separating unit used in the experiments

Sage (*Salvia officinalis*) plants have been dried in the rooms at 35°C after harvesting.

When medicinal plant materials are prepared for use in dry form, the moisture content of the material should be kept as low as possible in order to reduce mould damage and other microbial infestation (Máthé, 2015).

Therefore, the moisture content value of sage plant has been selected as 10.1%d.b. between 10-12%.

In order to determine the separating performance of system for sage plant the experiments have been conducted at 3 different sieves type content as 4-20, 6-20 oblong sieves and 10 mm round hole sieve.

The sieve velocity of the unit has been determined as 35, 40 and 45 Hz. 3 different sieves inclination of separating unit have been adjusted as 14, 15.8 and 17.6%.

The product feeding rates have been determined as 190, 380, 570 kg/h. Each experiment has been performed in 3 replicates.

The operating parameters of the separating unit for sage plant carried out at 3 different sieve types have been given in Table 1.

Table 1. The operating parameters of the separating unit for sage plant

Sieve velocity (Hz)			Sieve inclination (%)		
1	2	3	1	2	3
35	40	45	14 (8°)	15.8 (9°)	17.6 (10°)

RESULTS AND DISCUSSIONS

According to results of the experiments conducted with different sieves for sage plant, depending on sieve velocity, feeding rate and sieve inclination of the separating unit, the separating efficiency values have been range from 41.44% to 97.49%.

The separating unit efficiency values for sage plant depending on the 3 different sieve types have been given in Figure 2.

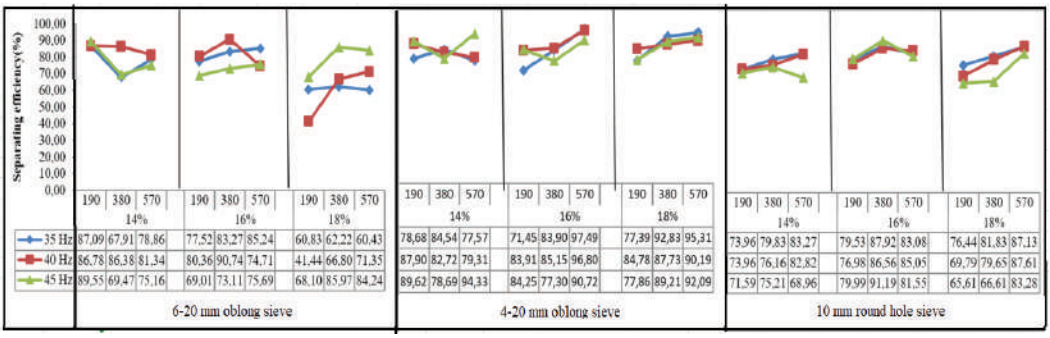


Figure 2. The effect of sieve velocity, feeding rate and sieve inclination
on the separating efficiency with different sieve types

As a result of the separating experiments for sage depending on the sieve types, the highest separating efficiency value has been found at 15.8% sieve inclination, 380 kg/h feeding rate and 40 Hz of sieve velocity with 6-20 oblong sieve type. The lowest separating efficiency has been observed experiments conducted with 10 mm round hole sieve at 17.6% sieve inclination, 190 kg/h feeding rate and 40 Hz of sieve velocity. The separating efficiency value of the system were found low in the experiments carried out with 10 mm round hole sieve.

The triple interaction of sieve velocity, feeding rate and sieve inclination on the separating efficiency with 3 different sieve types have been found statistically significant ($p<0.05$).

According the result of the study conducted depending on the sieve types for sage plants, sieve velocity, feeding rate and sieve inclination of the separating unit, the work efficiency values have been given in Figure 3.

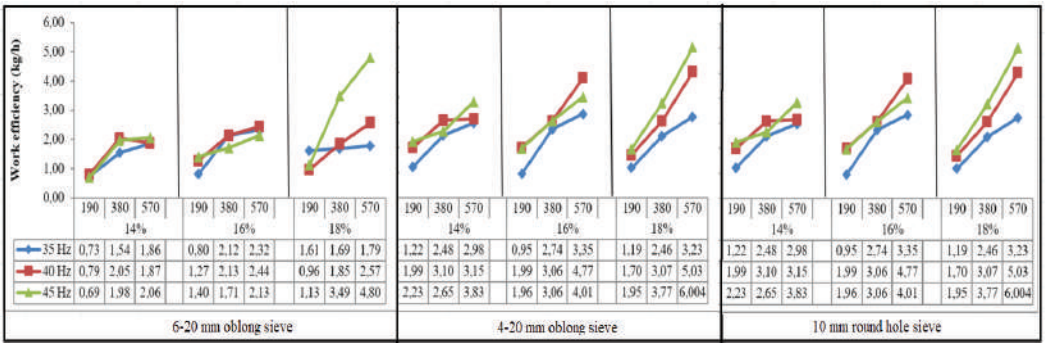


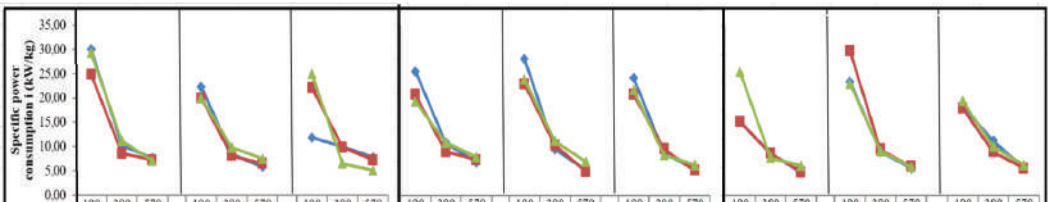
Figure 3. The effect of sieve velocity, feeding rate and sieve inclination on the work efficiency with different sieve types

The triple interaction of sieve velocity, feeding rate and sieve inclination on the separating efficiency with 3 different sieve types have been found statistically significant ($p<0.05$).

According to the result of the study depending on the sieve types for the sage plant, the work efficiency values has been found to be low at 4-20 mm oblong sieve type. The lowest value observed at 45 Hz sieve velocity, 190 kg/h feeding rate and 14% sieve inclination as 0.69 kg/h. The work efficiency values changed between 0.69 kg/h and 6.004 kg/h. The highest work efficiency value has been determined at 17.6% of sieve inclination, 45 Hz sieve velocity and 570 kg/h feeding rate in the experiment conducted with 6-20 oblong sieve.

Specific power consumption is one of the most important parameters for designing systems and must be known in order for the proper system performance of separating unit for sage plant.

The specific power consumption values of separating unit for sage plant carried out with 3 different sieve types have been presented in Figure 4.



6-20 mm oblong sieve

	14% 190	14% 380	14% 570	16% 190	16% 380	16% 570	18% 190	18% 380	18% 570
35 Hz	30,06	10,26	7,64	22,34	8,41	5,83	11,87	9,91	7,82
40 Hz	24,89	8,57	7,22	19,99	8,11	6,49	22,21	9,77	7,19
45 Hz	29,34	11,21	7,12	20,02	9,81	7,53	25,06	6,50	5,06

4-20 mm oblong sieve

	14% 190	14% 380	14% 570	16% 190	16% 380	16% 570	18% 190	18% 380	18% 570
35 Hz	18,23	7,70	4,87	20,03	6,75	3,68	17,24	6,25	3,92
40 Hz	14,78	6,43	5,20	16,36	7,35	3,52	14,78	6,83	3,62
45 Hz	13,78	7,74	5,61	17,03	8,00	4,93	15,47	5,92	4,48

10 mm round hole sieve

	14% 190	14% 380	14% 570	16% 190	16% 380	16% 570	18% 190	18% 380	18% 570
35 Hz	13,06	7,42	3,99	20,13	7,76	4,82	15,83	9,66	4,76
40 Hz	13,06	7,42	4,10	25,64	8,13	5,09	15,44	7,66	4,75
45 Hz	21,85	6,60	5,28	19,82	7,88	5,01	16,79	8,59	5,34

Figure 4. The effect of sieve velocity, feeding rate and sieve inclination on the specific power consumption with different sieve types

The specific power consumption values of the system according to the measured values depending on the sieve types for the sage plant, sieve velocity, feeding rate and sieve inclination of the separating unit, varied between 3.52 kW/kg and 30.06 kW/kg.

The triple interaction of velocity, feeding rate and sieve inclination on the specific power consumption with 4-20, 6-20 oblong sieves and 10 mm round hole sieve have been found statistically significant ($p<0.05$).

While the specific power consumption of separating unit for sage plant has been lowest at 15.8% sieve inclination, 570 kg/h feeding rate and 40 Hz of sieve velocity with 6-20 oblong sieve type, it has been highest at 14% sieve inclination, 190 kg/h feeding rate and 35 Hz sieve velocity with 4-20 oblong sieve type.

CONLUSIONS

In this study, separating unit performance values and working parameters have been determined for the sage plant, which has important cultivating areas for our country and Mediterranean region. The separating efficiency, work efficiency and specific power consumption values of threshing unit for the sage plant have been determined.

When the separation unit for sage plant is examined in terms of separating efficiency, it has been suggested to operate with 10 mm round-hole sieve at 570 kg/h feed rate, 35 Hz sieve velocity and 17.6% sieve inclination.

On the other hand, it is suggested that for the high work efficiency, separating unit can be performed with 6-20 mm oblong sieve, at 570 kg/h feed rate, 45 Hz sieve velocity and 17.6% sieve inclination. In order to reduce specific power consumption of the unit the parameters must be selected as 15.8 sieve inclination, 570 kg/h feeding rate and 40 Hz sieve velocity with 10 mm round- hole sieve.

According to the results, it can be said that the most suitable sieve type for sage plant is 10 mm round-hole sieve. The optimum sieve inclination is 17.6% and the sieve velocity is 40 Hz.

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PRODUCTIVITY OF WINTER WHEAT ACCORDING TO THE NUTRITION LEVEL ON THE CHERNOZEM CAMBIC

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Abstract

The harvest of winter wheat on the chernozem cambic in the non-fertilized variant ranged from 1.33 to 3.22 t/ha during 2010-2016. Administration of fertilizers on the natural background on average for 7 years led to the increase of winter wheat yields from 2.51 to 4.75 t/ha, the production increase with 38-89%. On the phosphorus levels the crop yield increased from 19% on the 1.5 mg phosphorus level to 50% on the 3.0-3.5 mg of mobile phosphorus in soil versus the $N_{120}K_{30}$ background. On the variant $P_{30}K_{30}$ the increase in yield was 44% in comparison with control variant. At the nitrogen variants with PK in doses of 30-150 kg/ha the increase in wheat yield was 65-89% compared to the control and 20-45% relative to PK variant. The gluten content in average over 7 years ranged from 23.6% on the unfertilized variant to 29.6% on the fertilized variants. The gluten rate was 25% against the witness variant (23.6%), this is the second group of wheat quality. The optimum level of mobile phosphorus in the chernozem cambic for winter wheat cultivation was 3.0-3.5 mg/100 g of soil (Machigin method), and the optimum nitrogen doses were 90-120 kg/ha.

Key words: *chernozem cambic, fertilizers, nutrition level, productivity, winter wheat.*

INTRODUCTION

Productivity of agricultural crops largely depends on the soil moisture and actual soil fertility. Research conducted in the Republic of Moldova in long-term experience has shown that the average multiannual amount of precipitation ensures the production of 4.4 t/ha of winter wheat, 5.6 t/ha of corn for grains, 35.0 t/ha of sugar beet and 2.7 t/ha of sunflower seeds (Andrieş, 2007; HG nr.841 din 26.07.04, 2004; IPAPS, 2012). On the account of the natural soils fertility the 2.6 t/ha of winter wheat, 3.1 t/ha of corn grains, 26.0 t/ha of sugar beet and 1.5 t/ha of sunflower seeds can be obtained (Почвы, 1986). The untapped value of the harvests in humidity conditions of Moldova is 1.8 t/ha of winter wheat, 2.5 t/ha of maize grains, 9.0 t/ha of sugar beet and 1.2 t/ha of sunflower. These quantities can be covered by increasing the soil fertility through fertilizer management and improving the recommenddations for rational use of fertilizers.

The parameters of agrochemical indices of arable soils are very different and depend on their genesis and degradation form. The humus content in the arable layer (0-30 cm) ranges from 0.8-1.2% (very degraded soil) to 4.2-5.0% (soil with full profile), mobile phosphorus - from 0.6-0.8 mg to 6-8 mg/100 g of soil and exchangeable potassium - from 14-16 mg to 50-60 mg/100 g of soil. The agricultural soils are relatively rich in humus, the weighted average content is 3.1%.

During the organic matter mineralization process, annually about 74 kg/ha of nitrogen is produced in the soil, which is not enough to produce profitable wheat production. Regarding to the phosphorus content the soils in the republic are poor.

According to the last cycle of agrochemical soil mapping, about 60% of the surveyed area have an assurance degree below the optimum content of mobile phosphorus in the soil.

Up to 90% of the country's soils are relatively optimally insured with potassium (20-30 mg K_2O/100 g of soil) available to agricultural plants.

The main available potassium reserve is the exchangeable form, which is largely restored based on the disintegration of potassium minerals in the soil (Andrieş, 2007, 2011; Burlacu, 2000; IPAPS, 2012).

From the soil nutritive regimes in the first minimum is nitrogen and phosphorus.

In order to improve the fertilization system of the cambic chernozem, the wheat productivity and quality were evaluated according to the fertilization level and agrometeorological conditions of the 2010-2016 period.

MATERIALS AND METHODS

Field investigations were carried out at the Long-term Experimental Station (Ivancea, Orhei district), founded in 1964 on the clayey-loamy cambic chernozem. The chernozem cambic is characterised by humus content in the arable layer of 3.4%; pH_{water} - 6.7; ∑Ca+Mg - 37.4 mg/100 g of soil. Since 2000 the station is registered in the Eurosomnet.

In crops rotation were cultivated: winter wheat, corn for grains, sunflower, winter barley, rape and leguminous crops (alfalfa, peas, beans, soybeans). Experiences were performed in 4 repetitions. The plot area was of 200 m^2. Investigations were carried out on the following levels of soil mineral nutrition: *mobile phosphorus* - 1.0; 1.5; 2.0; 2.5; 3.0; 3.5; 4.0; 4.5 mg/100 g of soil; *exchangeable potassium fund in the soil* (Machigin method) has varied in these years, from 29 to 32 mg/100 g of soil. The level of mobile phosphorus in the soil were maintained by offsetting the phosphorus export from preceding crop and applying phosphorus fertilizer to the base tillage. Potassium fertilizers in experiences from 2010 up to the present does not apply. Nitrogen norms were applied annually - 0, 30, 60, 90, 120 and 150 kg/ha in active substance (Andrieș et al., 2014).

The phosphorus and potassium content of the soil was determined by the Machigin method (extracted in 1% ammonium carbonate solution in a ratio of 1: 20, pH-9). According to the Soil classification on mobile phosphorus and exchangeable potassium assurance of the soils in Moldova, the scale has 6 gradations, ranging from less than 1 mg to more than 7 mg/100 g of soil for mobile phosphorus and from less than 5 mg to more than 40 mg/100 g for exchangeable potassium of soils (IPAPS, 2012,).

RESULTS AND DISCUSSIONS

Agrometeorological conditions. The amount of precipitation, as well as their distribution during plant growing, has conditioned the productivity of winter wheat. Over the seven investigation agricultural years, the agro-meteorological conditions were different. From seven years, two years were relatively dry (2012 and 2015), with a humidity deficiency of 17-21% versus the multiannual average amount, fewer the droughts were 2014 and 2016 (Table 1).

Table 1. Amount of the atmospheric precipitation at the "Ivancea" Experimental Station in 2010-2016

Year	IX of 2009* - III		IV		V		VI		VII		VIII		IV-VIII		Agricultural year	
	mm	%	mm	%	mm	%	mm	%	mm	%	mm	%	mm	%	mm	%
2010	327	127	44	105	83	156	85	107	58	95	36	60	306	104	633	115
2011	245	95	49	117	26	49	195	247	31	51	17	28	318	108	563	102
2012	153	60	38	90	114	215	48	61	59	97	22	37	281	95	434	79
2013	293	114	20	47	64	121	84	106	126	206	46	77	340	115	633	115
2014	261	102	25	60	112	211	36	46	55	90	20	33	248	84	509	92
2015	325	127	39	93	10	19	33	42	37	61	15	25	134	45	459	83
2016	252	98	31	74	57	107	133	168	3	5	36	60	260	88	512	89
Average	265	103	35	83	66	124	88	111	53	87	27	45	269	91	534	97
Multiannual	257	100	42	100	53	100	79	100	61	100	60	100	295	100	552	100

****Note.*** *The period of the agricultural years is considered 01.09.2009 - 31.08.2016*

Nearly the norm was 2011 with 563 mm, making up 102%, over the norm or so-called "wet years" were 2010 and 2013, respectively 115%. On average of seven years the atmospheric precipitations were with 18 mm less than the multiannual average, constituting 534 mm. Precipitation during the cold period of the year (September - March) created favorable soil moisture reserves at early spring period, which influenced the normal growth and development of wheat plants. The amount of precipitation in the cold season at the station was near normal, representing 95-114% of the multiannual average, except for 2012 with the amount of rainfall of only 60%, as well as 2010 and 2015 with 127% above the norm.

The atmospheric precipitation for the active field crops grow (April - August) in these seven years decreased by 9% on average compared to the multiannual average, and by 2015 they were 55% fewer, constituting 134 mm. The strongest drought occurred in July and August, where the monthly rainfall in the years 2015-2016 decreased by 75-95% over the multiannual average and the air temperatures exceeded the norm by 2.0-3.9°C.

Productivity and quality of the winter wheat. Fertilizers have positively influenced the winter wheat growth and development. Their administration has led to the increase and improvement the production quality compared to the unfertilized variant. The winter wheat production on the unfertilized variant of cambic chernozem varied in seven years, from 1.33 to 3.22 t/ha. The size of the yields obtained on the natural background (fund) was influenced to a large extent by the meteorological conditions, but also by the preceding crop. On average, leguminous as a preceding crop, have increased the grain yield of wheat by 0.5 t/ha, versus sunflower as preceding crop.

The administration of mineral fertilizers on the natural background in seven years on average led to the increase of winter wheat yields from 2.51 to 4.75 t/ha. Winter wheat yield increase (efficiency) obtained was from 38% to 89%. On average, during seven years on phosphorus fertilization levels, the crop yield increased from 19% on the level of 1.5 mg of mobile phosphorus per 100 g of soil to 45-50% - on the level of 2.5-3.5 mg/100 g of soil versus $N_{120}K_{29-32}$ mg/100 g. In variant with fund $P_{3.5}K_{29-32}$ mg/100 g (PK) the increase in yield compared to the control was 44%. In the case of nitrogen variants in doses of 30-150 kg/ha on the background of PK, the increase of winter wheat yield was 65-89% compared to the control variant and 20-45% to the PK variant (Table 2).

In drought years the role of fertilizers has increased significantly in the formation of winter wheat yield. Although the global production has fallen in these years, the productivity compared to the unfertilized variant in 2012 practically doubled from 1.33 t/ha to 1.92-2.68 t/ha. The role of mineral fertilizers was decisive in the formation of winter wheat production.

The quality of the winter wheat was directly influenced by the application of fertilizers. The wet gluten content of wheat grains ranged from 16.0% to 40.8%. The average value of gluten in six years in the non-fertilized variant was 23.6%, increasing by 4.2-6.3% to 27.8-29.9% on the fertilized variants. The so-called "dilution effect" resulted in the production of winter wheat obtained on the $P_{3.5}K$ variant. The wheat harvest on this variant was 1.45 times higher than control, and the gluten content on average was the same - second group (Table 3).

The amount of gluten obtained in the cultivation of bakery wheat per unit area is an integral indicator of crop productivity assessment. This indicator enables us to determine the agronomic efficiency or yield of fertilizers in order to obtain wheat production. The amount of gluten obtained in the cultivation of winter wheat according to the level of fertilization on the cambic chernozem is presented in Table 4.

Table 2. Winter wheat yield obtained on cambic chernozem in dependence of the fertilization level, t/ha

Variant		Preceding crop, year of investigation								Average 2010-2016	The increase %
Nitrogen kg/ha	P_2O_5 mg/100 g soil	Alfalfa	Rape	Pease	Sunflower				Soybeans		
		2010	2011		2012	2013	2014	2016	2016		
Control	1.0	2.68	2.12	2.67	1.33	2.37	2.76	2.97	3.22	2.51	-
120	1.0*	3.83	2.89	3.44	2.17	2.65	3.34	4.85	4.58	3.47	38.2
120	1.5	4.19	3.18	3.67	2.23	3.77	3.73	5.60	5.24	3.95	57.4
120	2.0	4.25	3.84	4.04	2.32	4.03	4.08	5.81	6.35	4.34	72.9
120	2.5	4.50	4.08	4.41	2.52	4.25	4.26	6.14	6.57	4.59	82.9
120	3.0	4.51	4.12	4.62	2.48	4.65	4.46	6.16	6.76	4.72	88.0
120	3.5	4.62	4.27	4.76	2.60	4.69	4.32	6.02	6.67	4.74	88.8
120	4.0	4.70	4.24	4.69	2.63	4.55	4.26	6.14	6.38	4.70	87.2
120	4.5	4.64	4.26	4.75	2.58	4.58	4.22	6.08	6.60	4.71	87.6
0	3.5	4.49	3.01	3.39	1.92	3.22	3.54	4.21	5.27	3.63	44.6
30	3.5	4.61	3.63	3.93	2.33	4.03	3.93	4.61	6.09	4.14	64.9
60	3.5	4.72	3.87	4.16	2.54	4.22	4.28	5.78	6.36	4.49	78.9
90	3.5	4.73	4.07	4.57	2.68	4.52	4.59	6.32	6.55	4.75	89.2
120	3.5	4.53	4.22	4.74	2.62	4.69	4.19	6.24	6.73	4.75	89.2
150	3.5	4.21	4.05	4.49	2.53	4.58	4.08	6.08	6.46	4.56	81.7

**K - the exchangeable potassium content in the soil is 29-32 mg/100 g of soil.*

Table 3. Wet gluten content in wheat grains cultivated on the cambic chernozem, %

Variant	Preceding crop, year of investigation									Quality group
	Alfalfa	Rape	Pease	Sunflower				Soybeans	Average	
	2010	2011		2012	2013	2014	2016			
Control	30.8	20.4	21.6	32.4	21.2	22.8	18.4	21.6	23.6	II
$N_{120}P_{1.0}K$*	31.2	26.8	25.6	36.0	28.0	29.2	20.8	28.0	28.2	II
$N_{120}P_{1.5}K$	31.2	26.8	25.6	40.8	32.8	29.6	20.8	28.0	29.4	II
$N_{120}P_{2.5}K$	31.8	20.8	27.5	38.4	30.0	30.0	25.6	30.4	29.3	II
$N_{120}P_{3.5}K$	31.8	20.8	28.4	36.4	31.4	30.4	24.6	29.6	29.2	II
$N_{120}P_{4.5}K$	32.0	21.6	25.2	38.8	30.2	29.6	24.0	31.2	29.1	II
$P_{3.5}K$	29.2	16.0	20.8	34.0	23.6	25.2	18.8	21.2	23.6	II
$N_{60}P_{3.5}K$	31.6	22.4	23.2	376	28.8	31.2	20.8	26.8	27.8	II
$N_{90}P_{3.5}K$	30.8	24.4	28.8	37.2	31.2	31.2	25.2	28.4	29.6	II
$N_{120}P_{3.5}K$	32.0	23.2	26.4	38.4	28.0	28.4	26.4	28.8	29.0	II
$N_{150}P_{3.5}K$	32.0	26.0	28.0	38.8	32.8	28.4	26.4	26.6	29.9	II

**K - the exchangeable potassium content in the soil is 29-32 mg/100 g of soil.*

Table 4. Amount of gluten obtained from the cultivation of the winter wheat, kg/ha

Variant	Preceding crop, year of investigation									The increase, %
	Alfalfa	Rape	Pease	Sunflower				Soybeans	Average, kg/ha	
	2010	2011		2012	2013	2014	2016			
Control	825	432	577	431	502	629	546	695	580	-
$N_{120}P_{1.0}K$*	1195	774	880	781	742	975	1009	1282	955	64.6
$N_{120}P_{1.5}K$	1307	852	940	910	1237	1104	1165	1467	1123	93.6
$N_{120}P_{2.5}K$	1431	849	1213	968	1275	1278	1572	1997	1323	128.1
$N_{120}P_{3.5}K$	1469	888	1352	946	1473	1313	1481	1974	1362	134.8
$N_{120}P_{4.5}K$	1485	920	1197	1001	1383	1249	1459	2059	1344	131.7
$P_{3.5}K$	1311	482	705	653	760	892	791	1117	839	44.6
$N_{60}P_{3.5}K$	1492	867	965	955	1215	1335	1202	1704	1217	109.8
$N_{90}P_{3.5}K$	1457	993	1316	997	1410	1432	1593	1860	1382	138.3
$N_{120}P_{3.5}K$	1450	979	1251	1006	1313	1190	1647	1938	1347	132.2
$N_{150}P_{3.5}K$	1347	1053	1257	982	1502	1159	1605	1718	1328	129.0

**K - the exchangeable potassium content in the soil is 29-32 mg/100 g of soil.*

Administration of mineral fertilizers doubled the amount of wet gluten of wheat obtained at one ha from the natural background. During 2010-2016 years, on average, the fertilization levels the amount of wet gluten increased from 375 kg/ha to 802 kg/ha. Application of nitrogen fertilizers was significant at doses of 30-150 kg/ha on the background of PK resulted in a gluten of wheat increase of 378-543 kg/ha. The efficiency of the mineral fertilizers was significant, increasing from 44.6% to 138.3%, compared to the control variant. In order to obtain bread production, the maximum yield was 138.3% for the $N_{90}P_{3.5}K$ variant (Table 4).

CONCLUSIONS

The application of mineral fertilizers on the natural background of cambic chernozems led to an increase in the production of winter wheat by 38-89%. Phosphorus fertilization levels ranging from 1.5 mg to 3.0-3.5 mg/100 g of mobile phosphorus in the soil have led to 19-50% of wheat yield increases, and nitrogen fertilizers at doses of 30-120 kg/ha on the optimum fund $P_{3.5}K_{29\text{-}32}$ mg/100 g resulted in an increase of 20-45%. The optimum level of mobile phosphorus in the soil for cambic chernozem in the winter wheat cultivation is 3.0-3.5 mg/100g of soil (Machigin method) and the optimal nitrogen doses are 90-120 kg/ha.

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EVALUATION OF LOW HERBICIDE RATES OF GARDOPRIM® PLUS GOLD 550 SC AND SPECTRUM® 720 EC AT CONVENTIONAL SUNFLOWER (*Helianthus annuus* L.)

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Abstract

The aim of the study is to evaluate the efficacy of the herbicide products Gardoprim® Plus Gold 550 SC (312.5 g/l s-metolachlor + 187.5 g/l terbuthylazine) and Spectrum® 720 EC (720 g/l dimethenamid-p) in low rates. The field trial was conducted in 2016 and 2017 with the conventional sunflower hybrid P64 LL 125. The experiment was stated in the experimental field of the base for training and implementation of the Agricultural University of Plovdiv, Bulgaria. The trial was conducted by the randomised block design in 4 replications, and the efficacy was recorded by the 10 score visual scale of EWRS. The usage of tank mixtures of both studied herbicides lead to increased efficacy against some dicotyledonous weeds as Solanum nigrum L., Abutilon theophrasti L. and Amaranthus retroflexus L. Average for the period, for the treatments with Gardoprim® Plus Gold 550 SC in rate of 4000 ml ha^{-1} and the tank mixture of the herbicides the highest seed yields are recorded - 2.00 and 1.90 t ha^{-1}, respectively.

Key words*: sunflower, weeds, herbicides, low rates, efficacy.*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is the main oilseed crop in Bulgaria. In 2016, the harvested area of this crop was 817511 ha with an average yield of 2248 kg ha^{-1} (www.mzh.government.bg). In order to achieve high yields, along with the optimization of the main vegetation factors, it is necessary to effectively control the weeds.

A number of authors have been investigating the weed infestation of the sunflower fields. The most important weed species occurring in sunflower crops in Slovakia are *Agropyron repens, Iva xanthiifolia, Echinochloa crus-galli, Chenopodium album, Chenopodium hybridum, Amaranthus* spp., *Abutilon theofrasti, Datura stramonium, Convolvulus arvensis, Panicum miliaceum, Cirsium arvense, Fallopia convolvulus, Persicaria* spp. and *Polygonum* spp. (Týr and Vavrík, 2015). In Hungary, the most common weeds in this crop are *Ambrosia artemisiifolia, Chenopodium album, Convolvulus arvensis, Xanthium italicum, Echinochloa crus-galli, Panicum miliaceum* ssp. *ruderale and Setaria pumila* (Pinke and Karácsony, 2010). In Serbia, the main weed species occurring in the sunflower are *Amaranthus retroflexus* L., *Ambrosia artemisiifolia* L., *Bilderdykia convolvulus* L., *Cirsium arvense* L., *Chenopodium album* L., *Convolvulus arvensis* L., *Datura stramonium* L., *Echinochloa crus-galli* L., *Hibiscus trionum* L., *Polygonum aviculare* L., *Polygonum lapathifolium* L., *Polygonum persicaria* L., *Setaria glauca* L., *Setaria viridis* L., *Sinapis arvensis* L., *Solanum nigrum* L., *Sorghum halepense* (L.) Pers*., Stachys annua* L. *and Xanthium strumarium* L. (Konstantinovic et al., 2010).

In Bulgaria, the most common weeds in the sunflower fields are *Amaranthus* spp., *Sinapis arvensis* L., *Chenopodium album* L., *Cannabis ruderalis* Janisch, *Setaria* spp., *Echinochloa crus-galli* L., *Sorghum halepense* (L.) Pers., *Cirsium arvense* Scop., *Convolvulus arvensis* L., some new races of *Orobanche cumana* Wallr. etc. (Tonev et al., 2010; Manilov and Zhalnov, 2015). In the region of the cities of Plovdiv and Stara Zagora, Bulgaria it is found that in the sunflower fields *Amaranthus blitoides* L. and *Amaranthus albus* L. occupy much of the total weed infestation with annual weeds. The authors report that the most common perennial weeds is *Convolvulus arvensis* L. (Moskova et al., 2016).

The weed control in sunflower should be performed in the early phenophases of the crop. Reddy et al. (2012) reported that s-metolachlor + sulfentrazone (Broadaxe) imported 21 days before sowing or pre-emergence at 1100 g ha^{-1} controls *Amaranthus palmeri* S. Wats. and *Kochia scoparia* (L.) Schrad. by 95% and 100%, respectively. Good to excellent control (81-100%) against broadleaf weeds in sunflower is achieved after soil application of oxyfluorfen (Sharoxy 24% EC) (Osman et al., 2014). For the simultaneous control of grass and broadleaf weeds, Pannacci et al. (2007) recommend s-metolachlor + aclonifen and s-metolachlor + oxyfluorfen.
Tonev et al. (2010) found that pendimethalin (Stomp New) controls annual weeds. Oxyfluorfen (Goal 2E) has excellent broadleaf weed control and limited grass weed control efficacy. The tank mixture of s-metolachlor + terbuthylazine (Gardoprim Plus Gold) has higher efficacy against the grass and the broadleaf weeds (Tonev et al., 2010).
With sufficient soil moisture, the herbicides Stop Aqua, Gardoprim Plus Gold, Wing-P, and Pledge 50 had very good control over the annual weeds except for *Xanthium strumarium* L. (Manilov and Zhalnov, 2015).
The aim of the study is to evaluate the efficacy of the herbicide products Gardoprim® Plus Gold 550 SC and Spectrum® 720 EC applied in low rates.

MATERIALS AND METHODS

The trial is conducted by the randomized block design in 4 replications. The size of the experimental plot is 28 m². The conventional sunflower hybrid P64 LL 125 is grown. Variants of the trial are: 1. Untreated control; 2. Gardoprim® Plus Gold 550 SC - 4000 ml ha^{-1}; 3. Gardoprim® Plus Gold 550 SC - 3200 ml ha^{-1}; 4. Spectrum® 720 EC -1200 ml ha^{-1}; 5. Gardoprim® Plus Gold 550 SC + Spectrum® 720 EC - 3200 + 800 ml ha^{-1} (tank mixture). Gardoprim® Plus Gold 550 SC contains 312.5 g/l *s-metolachlor* + 187.5 g/l *terbuthylazine*, and Spectrum® 720 EC - 720 g/l *dimethenamid-p*. The experiment is stated on the experimental field of the base for training and implementation of the Agricultural University of Plovdiv, Bulgaria. The sowing is performed in the optimal time for the region. Predecessor of the sunflower is winter wheat - for both experimental years. On the trial field deep ploughing, two times disc harrowing and two times cultivation before sowing are done. Basic combine fertilization with 250 kg ha^{-1} NPK 15: 15: 15 and spring dressing with 200 kg ha^{-1} NH_4NO_3 is performed. The herbicide treatment is applied after sowing before germination of the crop (BBCH 00). The efficacy of the studied herbicides is recorded by the 10 score visual scale of EWRS (European Weed Research Society) on the 14^{th}, 28^{th} and 56^{th} day after application. The selectivity by the 9 score scale of EWRS is evaluated (at score 0 there are not damages on the crop, and at score 9 the crop is completely destroyed). The weed infestation is presented by *Sorghum halepense* (L.) Pers. (developed from rhizomes), *Sorghum halepense* (L.) Pers. (developed from seeds), *Echinochloa crus-gali* L., *Setaria viridis* L., *Chenopodium album* L., *Amaranthus retroflexus* L., *Xantium strumarium* L., *Abutilon theophrasti* Medik., *Datura stramonium* L. and *Solanum nigrum* L.

RESULTS AND DISCUSSIONS

The results during both experimental years are corresponding. On the 14^{th} day after the treatments, the highest efficacy against the *S. halepense* developed from seeds, *E. crus-gali*, *S. viridis*, *Ch. album*, *A. theophrasti*, *D. stramonium* and *S. nigrum* was recorded for variant 2, followed by variant 5 (Table 1). The efficacy of Spectrum® 720 EC against the species of *C. album*, *D. stramonium*, *A. theophrasti* and *S. nigrum* was thelowest. No efficacy against *S. halepense* developed from rhizomes, for any of the treatments was reported. The results ageinst *X. strumarium* was similar.
On on the 28^{th} day after the treatments a decrease of the herbicide efficacy in comparison with the efficacy on the 14^{th} day eas recorded. For both experimental years, the highest herbicide efficacy (85-100%) against *S. halepense* developed from seeds was recorded on this reporting date. Very good to excellent efficacy against *A. retroflexus* for the treatment of Gardodipm® Plus Gold at the rate of 4000 ml ha^{-1} was observed (Table 2). For all

treatments, the lowest herbicide efficacy against *C. album* and *D. stramonium* was recorded. The efficacy against *X. strumarium* and *S. halepense* developed from rhizomes was null.

On the 56th day after treatment, there was a high secondary infestatien with a *C. album*. Low efficacy against *C. album*, *S. viridis*, *A. theophrasti* and *D. stramonium* was reported (Table 3). For both years satisfactory efficacy was found against *S. halepense* developed from seeds and *A. retroflexus.*

The results for the obtained sunflower seed yield showed that during the two experimental years there are significant differences between the treated variants and the untreated control (Table 4). By Duncan's multiple range tests was found that the highest seed yield for the treatments with Gardoprim® Plus Gold 550 SC - 4000 ml ha^{-1} (variant 2) and Gardoprim® Plus Gold 550 SC + Spectrum® 720 EC - 3200 + 800 ml ha^{-1} (tank mixture). The lowest yield was obtained from the alone treatment of Spectrum® 720 EC ate rate 1200 ml ha^{-1}, but it is statistically different from the yield reported for the untreated control.

Table 1. Efficacy of the studied herbicides on the 14th day after application (%)

Variants / Weeds	2016					2017				
	1	2	3	4	5	1	2	3	4	5
S. halepense (rhizomes)	-	0	0	0	0	-	0	0	0	0
S. halepense (seeds)	-	90	90	90	95	-	100	95	95	95
E. crus-gali	-	80	60	60	65	-	90	75	75	80
S. viridis	-	85	65	65	70	-	95	80	80	85
C. album	-	70	55	40	60	-	75	50	25	60
A. retroflexus	-	95	90	75	95	-	100	100	90	100
X. strumarium	-	0	0	0	0	-	5	0	0	5
A. theophrasti	-	90	80	30	90	-	80	65	15	75
D. stramonium	-	75	50	35	60	-	70	45	30	55
S. nigrum	-	100	90	40	90	-	90	80	35	80

Table 2. Efficacy of the studied herbicides on the 28th day after application (%)

Variants / Weeds	2016					2017				
	1	2	3	4	5	1	2	3	4	5
S. halepense (rhizomes)	-	0	0	0	0	-	0	0	0	0
S. halepense (seeds)	-	90	85	85	90	-	100	90	90	90
E. crus-gali	-	60	45	55	65	-	75	60	70	80
S. viridis	-	65	50	60	70	-	80	65	75	85
C. album	-	50	20	20	45	-	60	20	10	50
A. retroflexus	-	90	70	60	80	-	100	85	75	95
X. strumarium	-	0	0	0	0	-	0	0	0	0
A. theophrasti	-	85	70	20	80	-	70	55	10	70
D. stramonium	-	70	45	30	55	-	60	40	20	50
S. nigrum	-	90	80	35	85	-	80	75	30	75

Table 3. Efficacy of the studied herbicides on the 56th day after application (%)

Варианти / Weeds	2016					2017				
	1	2	3	4	5	1	2	3	4	5
S. halepense (rhizomes)	-	0	0	0	0	-	0	0	0	0
S. halepense (seeds)	-	85	80	80	85	-	95	80	85	85
E. crus-gali	-	55	40	45	60	-	70	55	60	70
S. viridis	-	60	45	50	65	-	75	60	65	75
C. album	-	10	5	5	10	-	25	0	0	25
A. retroflexus	-	85	65	55	70	-	90	80	70	85
X. strumarium	-	0	0	0	0	-	0	0	0	0
A. theophrasti	-	55	50	5	50	-	45	40	0	40
D. stramonium	-	60	40	25	45	-	50	30	10	40
S. nigrum	-	80	70	20	70	-	75	65	20	65

Table 4. Sunflower seed yield (t ha^{-1})

Treatments	2016	2017	Average for the period
	Yield (t ha^{-1})	Yield (t ha^{-1})	Yield (t ha^{-1})
1.	0.80 a	0.70 a	0.75 a
2.	2.00* d	1.90* d	1.95* d
3.	1.60* c	1.40* c	1.50* c
4.	1.10* b	1.00* b	1.05* b
5.	2.00* d	1.80* d	1.90* d

All treatments with star (*) are with proved difference with the untreated control, $P < 0.05$.

CONCLUSIONS

The treatment with Gardoprim® Plus Gold 550 CK at rate of 4000 ml ha^{-1} had satisfactory herbicide efficacy against *S. halepense* (from seeds), *A. retroflexus* and *S. nigrum*.

The treatment of Gardoprim® Plus Gold 550 SC + Spectrum® 720 EC - 3200 + 800 ml ha^{-1} in tank mixture had satisfactory efficacy against *S. halepense* (from seeds), *A. retroflexus* and *S. nigrum*.

The lowest herbicide efficacy against the dicotyledonous weeds was recorded after the alone treatmet with Spectrum® 720 EC - 1200 ml ha^{-1}

The highest seed yield among the treated variands for Gardoprim® Plus Gold 550 SC - 4000 ml ha^{-1} and Gardoprim® Plus Gold 550 SC + Spectrum® 720 EC - 3200 + 800 ml ha^{-1} (tank mixture) was recorded. The lowest yield was obtained from the untreated control.

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EFFECTS OF NITROGEN FERTILIZATION ON FORAGE YIELD AND QUALITY OF SMOOTH BROMEGRASS (*Bromus inermis* Leyss.)

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Abstract

This study aimed to determine the effects of five nitrogen doses (0, 40, 80, 120 and 160 kg ha^{-1}) on forage yield and quality of smooth bromegrass (Bromus inermis Leyss.*). Dry matter (DM) yield, crude protein (CP) ratio, neutral detergent fiber (NDF), acid detergent fiber (ADF), total digestible nutrient (TDN) and relative feed value (RFV) were determined. Nitrogen rates significantly affected all components determined in smooth bromegrass. Nitrogen applications increased DM yield, CP ratio, TDN and RFV values but decreased ADF and NDF ratios. At the end of this research conducted in Mediterranean conditions of Turkey, 120 and 160 kg ha^{-1} nitrogen doses are recommended for high herbage yield and quality in smooth bromegrass.*

***Key words**: smooth bromegrass, dry matter, neutral detergent fiber, relative feed value.*

INTRODUCTION

Smooth bromegrass (*Bromus inermis* Leyss.) is a high-yielding grass but requires longer recovery periods than other grasses. It is best adapted to well drained soils and is an excellent choice for drought prone areas (Undersander et al., 1996). Because of its highly developed root system, smooth bromegrass is resistant to temperature extremes and drought.

It grows best on deep, well-drained silt or clay loam but may also establish itself in sandier soils. The forage quality of smooth bromegrass is higher than that of most other cool-season grasses such as orchardgrass (*Dactylis glomerata* L.) or tall fescue (*Festuca arundinacea*); crude protein levels in smooth bromegrass often exceed 120 g kg^{-1} if it is harvested in the boot stage.

However, smooth bromegrass recovers poorly from cutting because its tiller apices, or tips, are vulnerable to removal. This leads to lower yields after a first cutting and poor seasonal distribution of yield. In addition, older stands may easily become dense and sod-bound, resulting in markedly lower productivity.

Plant nutrients are the most important, and readily manageable, variables for producing a profitable crop. Nitrogen, because of its high demand in the plant and variability within the soil, is the most intensively managed plant nutrient in crop production (Lingorski, 2000; Lingorski, 2002). Grasses need nitrogen more than many plant groups need it.

Organic matter and nitrogen deficiency could be removed by fertilization in agricultural areas including dry farming in Turkey (Serin et al., 1999; Koc et al., 2004). McGinnies (1968) and Power (1985) reported that increasing N fertilization increased dry matter yield in grasses.

The nutrient contents of the forage have an important role in animal feeding. The factors influencing the nutritive value of forage are many, and the degree to which they are interrelated may vary considerably from one area to another.

These factors may include, alone or in combination, plant type, climate, season, weather, soil type and fertility, soil moisture, leaf to stem ratio, and physiological and morphological characteristics, and may change depending on whether the plants are annuals perennials, grasses or legumes (Turk et al., 2009).

The objective of this research was to determine the effects of different rates of nitrogen fertilizers on yield and nutritional value of smooth bromegrass.

MATERIALS AND METHODS

The research was conducted at Isparta (37°45′N, 30° 33′E, altitude 1035 m) located in the Mediterranean region of Turkey, between 2014 and 2016 years. The major soil characteristics, based on the method described by Rowell (1996) were as follows: the soil texture was clay-loam (clay: 31.2%, silt: 45.1%, sand: 23.7%); organic matter was 1.1% by the Walkley-Black method; total salt was 0.3%; lime was 7%; sulphur was 12 mg kg^{-1}; extractable P by 0.5N $NaHCO_3$ extraction was 3.3 mg kg^{-1}; exchangeable K by 1N NH_4OAc was 119 mg kg^{-1}; pH was 7.1 in soil saturation extract. Soil type was a calcareous fulvisol.

The experiments were evaluated in a randomized complete block design with three replications. Sowing was done by hand on 15 March in 2014. Seeding rates were 25 kg ha^{-1}. Plot sizes were 2.1 x 5 m = 10.5 m^2. Smooth bromegrass fertilized at the rates of 0, 40, 80, 120 and 160 kg N ha^{-1}. Calcium ammonium nitrate 26% was used as fertilizer. Herbage was not harvested during the growing season of 2014 due to the establishment year. All plots had been harvested only once every year (50% flowering stage of smooth bromegrass). Samples taken from each plot were dried at room temperature then dried in an oven at 65°C till they reached constant weight.

After cooling and weighing, the samples were ground for crude protein, ADF and NDF content analyses. Nitrogen content was calculated by the Kjeldahl method. The ANKOM Fiber Analyzer was used for NDF and ADF analysis. ANKOM F57 filter bags were used for ADF and NDF analysis in this study. Total digestible nutrients (TDN) and relative feed value (RFV) were estimated according to the following equations adapted from Horrocks and Vallentine (1999):

TDN = (-1.291 x ADF) + 101.35;

DMI = (120/%NDF, dry matter basis);

DDM = 88.9 – (0.779 x %ADF, dry matter basis);

RFV = %DDM x %DMI x 0.775.

The data were analyzed together using the Proc GLM (SAS 1998). Means were separated by LSD at the 5 % level of significance.

RESULTS AND DISCUSSIONS

The results of ANOVA summarized in Table 1. The results of variance analysis showed that DM yield, CP, ADF, NDF, TDN and RFV values in smooth bromegrass were influenced significantly by nitrogen treatments (Table 1).

Table 1. Results of Analysis of Variance Traits Determined

	df	DM Yield	Crude Protein	ADF	NDF	TDN	RFV
Block	2	ns	ns	ns	ns	ns	ns
Nitrogen	4	**	**	**	**	**	**
Error	8						

**Significant at 1 percent level, ns: non-significant.

The highest DM yields were obtained from 120 and 160 kg ha^{-1} N rates (3.55 and 3.56 t ha^{-1}), while the lowest DM yield (2.81 t ha^{-1}) was obtained from control plot (Table 2). Lauriault et al. (2002) reported that N is the most important fertilizer nutrient required for growing grasses. Increase in DMY due to N application is well documented by many authors (McGinnies, 1968; Power, 1986; Hall et al., 2003; Scarbrough et al., 2004). Crude protein content of forage is one of the most important criteria for forage quality evaluation (Holechek et al., 1989; Vogel et al., 1993). Increasing N fertilization rates resulted in an increase in CP ratio of smooth bromegrass (Table 2). The highest CP ratio was obtained from 160 kg ha^{-1} N rates (12.02%), while the lowest CP ratio (8.91%) was obtained from control plot (Table 2). These results are in agreement with those reported by Jacobsen et al. (1996) and McCaughey and Simons (1998).

Other important quality characteristics for forages are the concentrations of NDF and ADF (Haferkamp et al., 1987; Karn et al., 2006). The effects of nitrogen fertilization on ADF and NDF contents of smooth bromegrass were found statistically significant. In present study, increasing N fertilization decreased ADF and NDF concentration. The highest ADF (45.11%) and NDF contents (59.55%) were obtained from the control treatment, while the lowest ADF (36.38%) and NDF contents (51.49%) were obtained from the 160 kg ha^{-1} N treatment (Table 2).

The TDN refers to the nutrients that are available for livestock and are related to the ADF concentration of the forage (Sürmen et al., 2011). As ADF increases there is a decline in TDN which means that animals are not able to utilize the nutrients that are present in the forage (Aydın et al., 2010). The highest TDN values (54.38) was obtained from 160 kg ha^{-1} N rate, while the lowest TDN values (43.11) was obtained from the control treatment (Table 2). Similar results were reported by Albayrak and Türk (2011).

The RFV is an index that is used to predict the intake and energy value of the forages and it is derived from the DDM and dry matter intake (DMI). Forages with an RFV value over 151, between 150-125, 124-103, 102-87 and 86-75, and less than 75 are considered as prime, premium, good, fair, poor and reject, respectively (Lithourgidis et al., 2006). The highest RFV value (109.38) was obtained from 160 kg ha^{-1} P rate, while the lowest RFV values (83.96) was obtained from the control treatment (Table 2). Similar results were reported by Albayrak and Türk (2011).

Table 2. The DM yield, CP, ADF, NDF, TDN and RFV values of smooth bromegrass at different nitrogen doses

Nitrogen fertilization (kg ha^{-1})	Dry Matter Yield (t ha^{-1})	Crude Protein (%)	ADF (%)	NDF (%)	TDN	RFV
0	2.81 d	8.91 e	45.11 a	59.55 a	43.11 e	83.96 e
40	3.13 c	9.88 d	43.34 b	58.01 b	45.40 d	88.40 d
80	3.40 b	10.33 c	42.01 c	56.14 c	47.12 c	93.06 c
120	3.55 a	11.11 b	39.15 d	53.21 d	50.81 b	102.07 b
160	3.56 a	12.02 a	36.38 e	51.49 e	54.38 a	109.38 a

CONCLUSIONS

Smooth bromegrass has adequate mineral content for ruminant animal requirements for production in the Mediterranean region of Turkey. Increasing N rates resulted in increased forage yield and quality. The highest DM yields were obtained from 120 and 160 kg ha^{-1} N rates. The content of CP increased while increasing N treatments. As N rate increased from 0 to 160 kg ha^{-1}, ADF and NDF contents decreased, TDN and RFV values increased. At the end of this research conducted in Mediterranean conditions of Turkey, 120 and 160 kg ha^{-1} nitrogen doses are recommended for high herbage yield and quality in smooth bromegrass.

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THE CURRENT STATE OF SPRAYER MANUFACTURERS IN TURKEY AND SOME STRATEGİES FOR THE FUTURE

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Abstract

In Turkey, crop sprayers are one of the most used plant protection machines. These crop sprayers have different tank volumes, work widths, nozzles, control units etc. In this study, a survey on mounted crop sprayers was conducted by interviewing nineteen different manufacturers, taking into consideration the factories which produced the most crop sprayers in nine different cities in Turkey and getting technical information about crop sprayers boom manufactured by the companies. Technical specs about companies and products for sprayer manufacturers, safety regulations, costs of steel components were asked and the data obtained were evaluated. According to the results obtained, 48% of the companies manufacture crop sprayers with 400 L tank capacity and 10 m sprayer boom width most commonly, 94.74% of the manufacturing companies stated that they produce in compliance with the Machinery Safety Directive and 35.46% of them are consumables as the highest cost in the production of the sprayer booms. Advices of decreasing manufacturing cost, machine safety regulations and suitability of related standarts TS 4807 and TS 4808 were also made.

***Key words**: crop sprayers, machinery safety directions, cost of field sprayer boom manufacturing.*

INTRODUCTION

In Turkey, there are 1,169 thousand sprayers that consist of approximately 416 thousand field, 117 thousand orchards, 628 thousand backpack sprayer and 18 thousand other types of sprayers in use. Total arable areas are approximately 24 million hectares and about 84 percent of these areas are used for filed crop production, others are for orchard plants. Due to this production pattern, field crop boom sprayers are mostly used in Turkey.

Since pesticide spraying affects the yield and quality of the product, the application of the process as a uniform to all the plants in the area is the main aim of the pesticide treatment. Pesticide application machines and equipment are also designed and produced for this purpose. Locally made plant protection machines have replaced plant protection equipment, which entered into the agriculture of Turkey, by importation. Nowadays, numbers of high quality plant protection manufacturers are increasing. Beside these, plant protection equipment can be manufactured without engineering calculations. Because of that reason failure can be occur during the working of the plant protection machines. There are more than 150 sprayer manufacturing companies in Turkey.

Demir and Çelen (2005) conducted a survey on the situation and problems of field sprayer in 718 agricultural enterprises in Tekirdag province of Turkey. In the study, it was stated that the field sprayers which are subjected to the survey changed between 300-800 liters of tank capacity and about 69.7% of the field sprayers had a tank capacity of 400 liters. Also 43% of these field sprayer has 12 m boom width.

Yurtlu et al. (2012) found that farmers' level of education on safe machine use was low in their research on risk perceptions of agricultural machine use. The risk importance ratings of plant protection machines (sprayers, atomizers, dusters, fogging machines etc.) were determined in the study and it was stated that the plant protection machines took second place after agricultural transportation means within all agricultural machines with a total score of 356.8.

Demir (2015) was intended to determine the projection of plant protection machines in the Central Anatolia Region of Turkey. The use of tractor mounted field sprayer’s number increased from 37.289 in 2004 to 43.278 in

2013. According these data as calculated foreseen projection of field sprayers' number will be 50.640 in 2023

The objective of this study was to determine the state of Turkish agricultural sprayer manufacturers via a survey, taking into some considerations such as; tank capacity, boom width, technical issues about companies and products for sprayer manufacturing; compliance machine safety regulations, costs of steel components of sprayers

MATERIALS AND METHODS

In this study, a survey organized for the tractor mounted field sprayer manufacturers to search the spray arm widths, tractor power, storage capacity etc. issues in Turkey. Addition to this, manufacturers have been able to identify innovation considerations for field sprayer boom manufacturing, compliance with machine safety, maintenance. Face to face interviews were held with 19 tractor mounted field sprayer manufacturers from 9 provinces of Turkey (Adana, Aydın, Burdur, Bursa, Istanbul, Konya, Manisa, Mersin, Şanlıurfa) for this purpose.

RESULTS AND DISCUSSIONS

The data obtained as a result of survey work are presented in the following subheadings.

Evaluation of sprayer tank capacities and boom width

According to survey results firstly, it is understood that all manufacturers are manufacturing the tractor mounted field sprayers with 400 l, 600 l, 800 l and 1000 l nominal tank capacity. Beside these 100 l, 200 l, 300 l, 500 l, 1200 l, and 1600 l are also manufactured but not used widely (Figure 1).

Despite the fact the field sprayer with 1200 and 1600 liter tank capacities are available in the manufacturers, according to the standard TS 4807 (current standard of Turkish Standard Institute about tractor mounted field sprayer) tractor mounted type field sprayers are not suitable for 1200 l and 1600 l tank capacities because of overturn of tractors.

However, manufacturers still offer these machines in the market, ignoring the relevant standard.

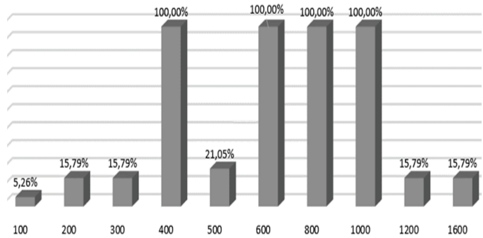

Figure 1. Manufacturing percentages of nominal tanks capacities in companies (liter)

As in Figure 1, mostly manufactured tanks' (400 l, 600 l, 800 l, 1000 l) relation with field sprayer boom width is searched. According to results, 48% of companies are manufacturing 400 l tank capacity with 10 m boom width, beside this 39.68% of companies are manufacturing 600 l tank capacity with 12 m boom width, 25.48% of companies are manufacturing 800 l tank capacity with 16 m boom width, 25.18% of companies are manufacturing 1000 l tank capacity with 16 m width. As known, big tank capacities have high chasis of crop sprayers. Whether the boom width increase, vibrations on the crop sprayer boom also increase. To prevent this, chassis and boom width must have relevance ratio which must increase both storage tank capacity and boom width as in relationship of prototype and model. This standardization will decrease failures in applications.

Relevance of compliance machine safety regulations (European Machinery Directive 2006/42/EC) of tractor-mounted field sprayers

In survey, it was questioned that if the tractor mounted field sprayers are proper for CE document. For 94.74% of the companies, CE document is available. Then it was asked that if clean water is available for cleaning the field sprayer. As an answer, 94.74 of companies denote that there is cleaning water tank on the field sprayer. According to results, 73.68% of companies are using waterjets for cleaning the inside of the tanks. Beside this, sprayers in 57.98 % of companies had the system which sends the pesticide directly into storage tanks without hand touch. The tractor mounted field sprayers that manufactured in Turkey, as the ratio of 73.68 %, had the system prevents overturn when machine is parked. Also, 94.74% percentage of these field sprayers had the traffic signs on it. By the way, 68.42% of companies had the protection on electrical lines in field sprayer which have the high storage capacity. Furthermore, the questions about, location of the signs and warnings are proper or not, the protection on hydraulic lines are available or not, cleaning water is available or not, for operator cleanness PTO cover is available or not, system of unloading the storage tank is safe or not, boom lock system during the traffic travel is available or not, are also asked. All the companies are answered these questions as affirmative.

In the work done, most firms stated that they had CE marking machines. It is learned that a large majority of companies have a clean water tank for machine washing purposes. It is important that there is enough water to clean the machine locally in any case. Jet system is required for washing inside the spraying tank. It is an important matter to dilute the residues in the tank with the pressurized water. It seems that this system exists in the great majority of companies. According to Turkish TS 4807 standard; there must be a discharge plug at the bottom of the pesticide tank to provide complete discharge of the tank. At this point, the liquid which can be prevented from being left in the tank can go out from the drain tap with its own. According to TS 4808 type of field sprayer standard, the tank filling system must supply water to the tank with the vacuum brought by the pump. The system which prevents the overturning in the park, is generally made by attaching 4 tires to the lower part of the field sprayer chasis. These wheels must also be supported with wedges. The designers must also determine the position of the center of gravity of the machine in the CAD program and position the wheels accordingly. The electrical cables must be in a housing, preventing easy access by uninformed people. It also prevents an external load from damaging the cables. However, most companies do not fulfill this requirement. When the field sprayer is taken to the field where it will work, it will definitely go to traffic. Therefore, it is necessary to make traffic markings on the machine.

Manufacturing costs of the field sprayer booms

In the field study, steel construction costs of the manufacturers were evaluated and it is understood that 5.26% of the companies did not calculate the steel construction costs. As shown in Figure 2, 35.46% of the manufacturers consider that the consumables (sheet metal, profiles etc.) are the most expensive part of the manufacturing.

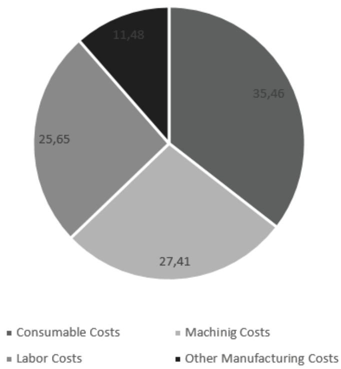

Figure 2. Manufacturing cost distribution of field sprayer boom according to manufacturers

Manufacturing costs (turning, milling, laser cutting etc. operations) are the second after consumables as the ratio of 27.41%. Labor cost have the ratio of 25.65% ratio which is higher than other manufacturing costs (electrical costs, water costs etc.) which have the ratio of 11.48%.

Cost Reduction Studies of Sprayer Arms

As shown in Figure 3, 52.63% of the companies stated that they changed the design. 36.84% of companies change their raw material supplier and sell cheaper and quality products. For a better quality and economical sprayer, 31.58% of firms have stated that they try a different manufacturing method. For a better quality and economical sprayer, 31.58% of the firms stated that they tried a different mounting method.

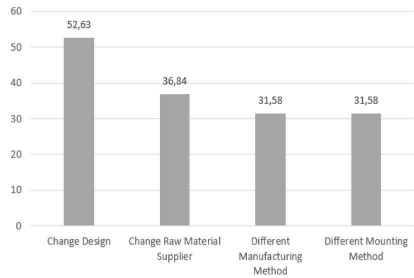

Figure 2. Studies done by companies in order to make their products better and more economical

In the study, some companies also aim to bring the user to a more efficient sprayer thanks to serious R&D activities. In these R&D studies, the software of low pressure electronic regulators is used, beside this aluminum material usage in sprayer booms, using nitrogen in the hydraulic piston to open and close the opening and closing hydraulic systems more slowly. Being close to the raw material and being located in large industrial sites allows manufacturers to purchase more suitable crop sprayer parts.
By using the technology adapted manufacturing method in production, better quality and economical products will be marketed. As can be seen in Figure 4, if the welding is done with a robot, better quality and faster welding can be done, thus labor costs can be reduced and more quality and economical products can be marketed.
Reducing the use of bolts and nuts in this phase, spreading sheet metal applications, welding rather than bolt-nut connections is effective in reducing sprayer installation costs.

Figure 4. Robot welding used during welding of field sprayer chassis and booms

CONCLUSIONS

Companies mostly manufacture 400 l storage tank capacity 10 m boom width with percentage of 48%.
In the study conducted, it is found out that most of the manufacturers are informed about machine safety, but their field sprayers do not fulfill some of these applications.
The agricultural sector is a sector where many accidents are experienced.
In order to prevent any accidents that may occur in the machines manufactured for this sector, the manuals should include warnings and markings on the machines, which will inform the user to avoid job accidents.
Beside these, there are some studies to decrease manufacturing costs which also will be reflected to product's price.

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THE EFFECT OF DIFFERENT TILLAGE PRACTICES ON THE SOIL BACTERIA MICROFLORA IN WINTER WHEAT CULTIVATION

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Abstract

Soil microorganisms play an important role in the sustainability of soil vitality and productivity. In agricultural production, nutrients needed by plants are converted into useful form for plants by microorganisms. Intensive agricultural activities on agricultural soils are a serious threat to soil microorganisms and threaten the sustainability of agriculture in the long run. Soil treatment practices are known to be effective on soil microbial flora. This study was carried out in vertisol soil in Diyarbakır to investigate the effectiveness of conventional tillage, reduced tillage and direct seeding practices on soil microbial flora in the 2016-2017 winter wheat sowing period. Soil samples were taken from the rhizosphere of the wheat plant during the sowing time and flag leaf phenological period. Dilution technique was applied to the samples to determine live bacteria quantities. As a result of the study, it was determined that different tillage practices have a significant effect on soil bacterial count. It was determined that direct seeding (NT) application was significantly increased the number of soil bacteria compared to conventional tillage (CT) and reduced tillage (RT) treatments (p<0.001).

Key words: *soil bacteria, wheat, soil tillage, no-till.*

INTRODUCTION

Soil microorganisms play an important role in the continuation of soil fertility and productivity. Soil bacteria microflora is responsible for many processes that are necessary for the agricultural productivity of the soil. These processes include the recycling of plant nutrients, the protection of soil structure, the degradation of agricultural chemicals and pollutants, and the control of plant pathogenic microorganisms (Parkinson and Coleman, 1981; Lupwayi et al., 1998). Bacterial microorganisms in the soil are usually colonized on the soil surface, near the surface and on organic tissues (Chaudhry et al., 2015). The most important factors affecting both the intensity and composition of soil microbial flora are; environmental and soil temperature, amount of organic matter, inorganic nutrients, pH, climatic conditions and tillage activities.

The tillage activities included in these factors have a direct impact on all other factors, since they affect the aeration of soil, the distribution of organic matter in the top profile of soil, and moisture capacity. For this reason, the chosen tillage method affects the type and number of soil microorganisms. The widespread use of intensive and unconscious agricultural practices that involve too much intervention in the soil is among the greatest threats to soil ecosystem and biodiversity.

It is clear that intensive farming practices such as soil cultivation, monoculture production and chemical fertilizer application are detrimental effects on the formation of microbial flora in a wide range of soil bacteria (Gosling et al., 2006; Nyberg, 2006).

Wheat crop in the world and Turkey in terms of creating the raw materials for essential nutrients, is of a special importance compared to other agricultural products. GAP region with an area of 75 358 km^2 which is located in the Southeastern Anatolia Region of Turkey is corresponding to 9.7% of the total area of the country (Sessiz et al., 2006).

With the increase in the amount of land opened to irrigation in the context of GAP, intensive agricultural systems are applied in areas where, the soil are tilled in conventional methods. In this region where intensive agricultural systems are applied, at least two different crops are grown annually in plant rotation. In this rotation system, winter wheat + corn or winter wheat + lentil farming is widely used.

Approximately 1.2 million hectares of wheat are sown in the Southeastern Anatolia Region according to the data of year 2016, and it is the third most important production area after Central and Western Anatolia (TÜİK, 2017a).

This planting area corresponds to 15.79% of the total wheat cultivation area of Turkey (TÜİK, 2017b).

Conventional tillage methods are widely applied in the region, especially in wheat cropping after corn harvesting.

The field with corn stalk remaining from the previous product harvest on the surface is ploughed with a mouldboard plough and then tilled with secondary tillage implements. Although landfills have been abandoned in recent years due to increased fuel costs and accelerated loss of moisture from the soil, conventional tillage methods throughout the region are still widely preferred.

In conventional systems, intensive and deep tilling of the soil results in numerous adverse effects on the physical, chemical and biological properties of the soil, and significant improvements in both environmental and soil quality parameters are obtained in conservative soil treatments and direct seeding systems.

In this point, it is important to determine the level of soil cultivation and planting methods on the number of soil bacteria in terms of high yield and healthy plant growth.

Understanding the changes on the bacterial microflora and linking different tillage methods helps to ensure precisely regulated sustainable agricultural systems (Treonis et al., 2010; Wall et al., 2012; Zhang et al., 2015).

In this study, it was aimed to determine the effect of different tillage and sowing methods on the number of soil bacterial microorganisms, which is one of the most important of soil microorganisms during sowing and flag leaf phenology in winter wheat growing.

MATERIALS AND METHODS

The study was carried out within the period of 2016-2017 wheat cultivation season at Dicle University Research Farm in Diyarbakır province located in Southerneast of Turkey (37°53’22’’ latitude N, 40°16’38’’ longitude E, 670 m above sea level).

The study carried out on trial plots of 10 x 14 m, was planned in completely randomized parcel design with three replications.

The soil structures of the study area was given in Table 1.

Table 1. The soil structures of the study area

Depth (cm)					pH	Salinity	Organik Material	$CaCO_3$	P_2O_5	K_2O	Fe	Zn	Mn	Cu
	Sand (%)	Silt (%)	Clay (%)	Texture	(1: 2.5)	(mmhos cm^{-1})	%	%	kg da^{-1}		mg kg^{-1}			
0-30	4.8	39.1	56.1	C	7.3	0.1	1.0	11.8	3.9	184.9	5.9	0.5	9.6	1.4

As is seen in Table 2, three different tillage systems were applied in the study for wheat cultivation: conventional tillage (CT), reduced tillage (RT) and direct seeding (NT). The working width and the working depth of the equipments are in Table 3. Mouldboard plough with a 400 mm working depth is the main equipment of conventional tillage and is frequently used after especially after corn harvest.

Table 2. The systems and the treatments

Systems	*Treatments*
Conventional Tillage (CT)	• Stubble chopper • Mouldboard plough • Disc harrow (2 times) • Scraper • Seeding
Reduced Tillage (RT)	• Cultivator • Disc harrow (2 times) • Scraper • Seeding
Direct Seeding (NT)	• Stubble cutting • Seeding

Table 3. The sizes of the equipments used in the study

Soil tillage equipment	Working width (mm)	Working depth (mm)
Mouldboard plough	1200	400
Cultivator	1700	350
Discharrow	2100	210
Scrapper	2000	50
Drill (24 row)	4800	5

Commonly used bread wheat variety in the region was used as wheat seed. Irrigation of the wheat was carried out by sprinkler irrigation system. For the fertilizer requirement of wheat plants, 15-18 kg N da^{-1}, 8 kg P_2O_5 da^{-1} and 15-20 kg K_2O da^{-1} were given. No pesticides were used during the growing season. In the parcels that contains excessive amount of weeds, only the weeds were removed by hand and removed from the parcel.

Soil samples were obtained from two different periods; during the sowing and in the flag leaf phenological period of winter wheat. According to the simple random sampling method in each parcel, 27 soil samples were taken for each period in three replicates.

Soil samples were collected from 5-20 cm depth of points determined according to simple random sampling method with the help of a shovel, and is placed in a polyethylene bag (Bora and Karaca, 1970; Saygılı et al., 2006). The obtained soil samples were dried in room conditions and then passed through a 2 mm sieve to prepare for dilution technique. The reason for the selection of the dilution technique in the study is that it is only possible to count live and active bacteria in the dilution technique. Before studying, a preliminary study performed to determine the amount of dilution suitable for determining the number of soil microbial populations in the dilution technique; 1/100000 and 1/1000000. In addition to Nutrient Agar (NA) medium used as a general medium for bacteria (Johnson and Curl, 1972), Potato Dextrose Agar (PDA) medium was used for each sample in order to understand the effect of the medium in the study.

Before the analysis, Nutrient Agar (NA) and Potato Dextrose Agar (PDA) commercial formulations were prepared and autoclaved at 121°C for 20 minutes and sterilized under 1 atm. pressure. Later, the medium were poured into Petri dishes wrapped in parafilm and stored at +4°C in the refrigerator until the analysis was carried out. Soil samples were dried and passed through a 2 mm sieve and soil particles under the sieve were used in the study. The soil sample obtained by sieving in this way was pounded into a sterile ceramic mortar and came to henna consistency. After weighing 10 g on a precision scale, was put in a 250 ml volume of sterile Erlenmeyer. The dilution rate here is

1/10. 1 ml of the soil-water suspension in the prepared Erlenmeyer is transferred to a test tube containing 9 ml sterile water and mixed. 1ml of suspension in this test tube transferred to a test tube containing 9 ml sterile water and mixed again. This procedure was repeated in the same manner for 5 test tubes containing 9 ml of sterile water. The starting dilutions of the last two dilutions will be diluted to 1/100000 and 1/1000000.

100 µl (microliter) of the last two dilutions (1/100000 and 1/1000000) were pre-prepared with a micropipette using a sterile tip for each use, transferred to sterile Petri dishes containing rested NA and PDA medium, and spread through the sterile glass stick.

Thus, for every soil sample; A total of 4 Petri dishes were inoculated to a Petri dish containing 1/100000 dilution 1 NA and 1 PDA media and to a Petri dish containing 1/10000 dilution 1 NA and 1 PDA media. The inoculated Petri dishes were wrapped with parafilm, incubated at 24±1°C, and counts of bacterial colonies were recorded every day for 10 days (Çınar and Biçici, 1991; Saygılı et al., 2006). All laboratory studies were carried out in a sterile sowing cabinet. In this respect, it is aimed to prevent contamination from air or other sources.

The data obtained on the basis of ten day observations were recorded. The logarithmic transformation was performed to the obtained data because of a positive correlation between the variance of the groups and averages and statistical analysis was then performed by the SPSS program. The results were evaluated according to the statistical analysis of raw data.

RESULTS AND DISCUSSIONS

According to the results of analysis, the effects of soil tillage method, sampling time, medium and dilution on the number of bacteria were found statistically significant.

The treatment of CT is mostly used for seedbed preparation in wheat cultivation in the region. It is known that CT method has negative effects on soil and environmental protection. In this study, negative effects of the conventional soil tillage treatment on the number of soil bacteria was determined as predicted. On the other hand NT was significantly increased the number of soil bacteria compared to CT and RT treatments (Figure 1). Sirazuddin et al. (2016), determined that NT recorded maximum population of bacteria followed by RT and CT. Similar results showed that the abundance of soil bacteria founded greater in NT and RT than CT, even in different climates (Helgason et al., 2010; Kuntz et al., 2013; Shixiu et al., 2016).

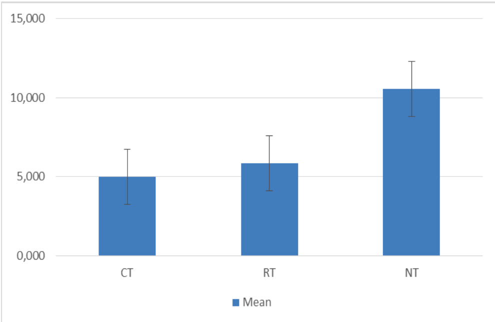

Figure 1. The means of bacteria after tillage practises
F = 9.509, df = 2,192, P<0.001

In the conventional tillage method, there was a significant decrease in the number of bacteria from the time of sowing until the time of flag leaf (Figure 2). Among the methods, statistically different and high values were determined for the number of bacteria in direct seeding method.

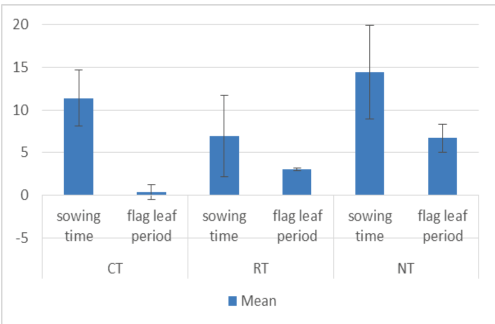

Figure 2. Effects of sampling time on the number of bacteria F = 6.288, df = 2,192, P<0.005

The influence of tillage on microbial diversity was more prominent at the flag leaf period than at planting time. When examined according to the methods, it is seen that the difference between the numbers of bacteria in the flag leaf period is fully opened between NT and CT.

As seen in Figure 3, the NA medium is directly effect on bacteria formation. As expected, the development of bacteria has become more in NA because it is the suitable medium for bacteria according to the PDA.
The number of bacteria in reduced tillage took the third place in the PDA medium, although it was the second in terms of bacterial count on the NA medium. The most serious decline in bacterial quantities in NA and PDA medium occurred in the samples taken from direct seeding parcels.

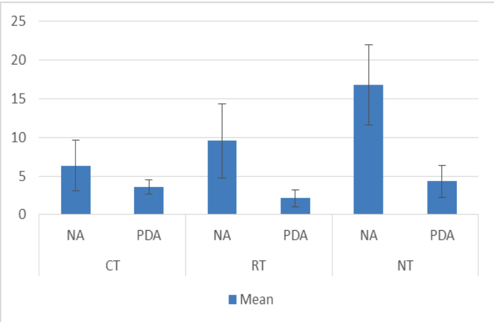

Figure 3. Effects of medium on the number of bacteria
F = 4.387, df = 2,192, P<0.05

CONCLUSIONS

In this study, as expected, the number of total bacteria is positively influenced by NT and RT. Also NT and RT systems prevent the number of bacteria from significantly decreasing from the time of sowing until the time of flag leaf.
Recorded significant decrease in the number of bacteria from the time of sowing until the time of flag leaf in conventional tillage system may result in reductions in diversity of soil organisms due to loss of the soil moisture, increased soil compaction, reduced pore volume and degradation of the rhizosphere layer by overtopping the soil.
Especially using of mouldboard plough in every cultivation season for various reasons, causes this negative factors.
Conservation tillage systems including direct seeding has been proposed to farmers, have a major role in abundance and richness of soil bacteria.
Considering the results of this study, adoption of the conservation tillage systems in wheat farming, which is one of the major sources of income for farmers in the region, supports bacterial growth and maintains soil sustainability.

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OBTAINING A FEED ADDITIVE BASED OF *Lactobacillus plantarum* STRAIN

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Abstract

The aim of the study was to isolate, identify and preliminary characterize strains of Lactobacillus spp. from the gastrointestinal tract of piglets. Three isolated strains were assessed morphologically, culturally, biochemically and enzymatically (amylase, celullase, protease). Successive replications were performed on MRS + $CaCO_3$ medium. The identification and analysis of the biochemical characteristics was performed by oxidase, catalase and API 50 CHL tests. From the all isolates, the Lactobacillus plantarum strain presents some potentially probiotic characteristics. The ability to synthesize organic acids (lactic, phenyl-lactic, hydroxyphenyl-lactic, acetic and propionic) was tested as well. The development of Lactobacillus plantarum was assessed on 4 variants of culture media containing different concentrations of ingredients (corn, soybean meal, substitute of milk). It was selected the first variant when was obtained 1.05 $x10^{10}$ CFU/ml of L. plantarum. The feed additive was based on LABs, by following the biotechnological process steps. The procedure was performed in the biotechnological installation (IL 00). Subsequently, the optimum level of feed additive will be established in weaned piglet's diet.

Key words: *Lactobacillus plantarum, feed additive, weaning piglets, strain characteristics.*

INTRODUCTION

Currently, animal husbandry is focused towards to a more natural strategy. Utilization of feed additives in their livestock diets may have an impact on the environment and animal health (Kiarie et al., 2016).

The administration of microbial preparations has started to be used in animal nutrition in, as early as, 1960 (Ahasan et al., 2015). Due to these concerns, from 1969, the use of antibiotics as „growth promoters" in animal nutrition was banned, thereby inducing resistance to infection and diseases (Balasingham et al., 2017).

The administration of live microbial preparations as „dietary supplements" provides a strategy for animal's breeders to raise up to the level of market requirements (high level of meat production, increasingly number of animals, early weaning etc.).

In the early 1990's, a drastic reduction of microbial preparations as living microorganisms in animal feed was noticed, which can be explained by misunderstanding the mechanism of action and the scarce scientific data (Simon et al., 2001).

In 2004, Caramia relaunched the use of living microorganisms as feed additives, process stimulated by the European Union, which decreed in 2006 the administration of antibiotics as growth promoters. The microorganisms used, belong to bacterial genera such as: *Bacillus* (Gram-positive spore forming bacteria), *Bifidobacterium, Enterococcus, Lactobacillus, Lactococcus, Streptococcus* and yeasts such *Saccharomyces*. The microorganisms mainly used in animal nutrition are: *Lactobacillus*, *Bacillus, Enterococcus* and *Saccharomyces* (Roselli et al., 2005; Stein and Kil, 2006; Musikasang et al., 2009, NRC, 2012).

The lactic acid bacteria (LAB) strains form a large group, characterized by a great diversity of species (*L. plantarum, L. acidophilus, L. rhamnosus, L. reuteri, L. casei, L. fermentum, L. johnsonii, L. salivarius* etc.). Around 71% of the LABs are used as feed additives in poultry and swine diets, while only about 29% of the species from *Bacillus* and *Enterococcus* groups are used (Khunajakr et al., 2008). For good results, a number of factors should be observed, such as: tolerant to acid in the stomach and bile salt in the intestine (Idoui, 2014); capacity to adhere to the host intestinal epithelium, to present antagonistic activity against pathogenic bacteria, to keep their viability during processing and storage (Lin et al., 2007); general health, feed conversion ratio, growth rates, resistance to diseases, promoting body weight, high quality of animal products etc. (Ahmad, 2006).

Microbial bioproducts based on: *Lactobacillus farciminis* and *L. rhamnosus* inhibit *in vitro* the viability and adhesion of *Brachyspira hyodysenteriae* and *Brachyspira pilosicoli* (pathogens in pigs and poultry) (Bernardeau et al., 2009); *L. johnsonii* and *L. pentosus* decreases the colonization of *Salmonella* spp. from pigs (Casey et al., 2004); *L. salivarius* and *L. pentosus* reducing the number of *Enterobacteriaceae* from pigs faeces (Gardiner et al., 2004); *Enterococcus faecium* increases the weight gain, feed conversion ratio and the dimensions of ileal villi in poultry (e.g. chicken) (Samli et al., 2007); *Bacillus subtilis* and *B. licheniformis* do not have a particular impact on the growth performance, weight, length, robustness and percentage of tibia calcium in broiler chickens, but improve the thickness of the medial and lateral wall of the tibia and the percentage of dry ash (Mutus et al., 2006); *L. johnsonii* controls the endemic necrotic enteritis caused by *Clostridium perfringens* in broiler chickens, reducing the economic losses and the use of antibiotics (La Ragione et al., 2004); the LABs inhibit *in vitro*, *Eimeria tenella* which is responsible for coccidiosis (Tierney et al., 2004); some *Lactobacillus* spp. increase the production of eggs, decrease the mortality, improve feed conversion ratio in laying hens (Yoruk et al., 2004); *Bacillus* strains, more stable due to spore forming, presents resistance to the processes of feed incorporation and granulation parameters, ensure long-term storage of forages (Simon, 2001).

The microbial candidates used as feed additives with probiotics role was defined, in 1992, by Fuller as „a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance". Idoui, in 2014, completed Fuller's probiotic definition: „microorganisms administered in adequate amounts, confer health benefits to the host and, as living microorganisms, induces no drug resistance or drug residues". Callaway et al. (2012), includes the term of probiotic as a „natural" strategy, to use microbial native population for diminished the pathogens bacteria.

Probiotic microorganisms can interfere by maintaining animal health, reducing the concentration of some toxic substances such mycotoxins (Trufanov et al., 2008; Niderkorn et al., 2009).

This study was conducted to obtain LABs with high probiotic properties and to use them as feed additive in weaned piglet's diet. This organism is a significant bacterium of the normal gut microbiota of piglet's and can induce a decrease in the number of pathogenic bacteria from animal gastro intestinal tract.

MATERIALS AND METHODS

Materials

Segments of gastrointestinal tract of healthy piglets were collected immediately after slaughter. The isolate was inoculated and grown in deMan, Rogosa and Sharpe (MRS, Oxoid), specific medium for *Lactobacillus* spp. Chemical reagents were used to assess the enzymatic activity of the isolates, which were selected and identified. The biotechnological product support was produced from raw forages (malt, soybean meal, milk substitute).

The research was carried out at the Laboratory of Biotechnology of the National Research and Development Institute for Animal Biology and Nutrition Balotești (INCDBNA), Romania.

Methods

Sample collection

LABs were obtained from intestine segments which were washedbefore with sterile physiological saline (NaCl 0.85%), until the all intestinal content was removed. The intestinal samples were cut into pieces of approximately 1 cm^2 and were inoculated in MRS broth medium (Oxoid), at 37°C, for 24 h, in anaerobic conditions.

Decimal dilutions (10^{-8}) were produced. From 10^{-4}-10^{-8} it was cultivated in Petri dishes with MRS agar medium, at 37°C, for 24 h. A pure culture was obtained by successive replications.

Identification of strain isolates

Isolation and selection of lactobacilli strains was done on MRS agar (Oxoid) supplemented with 0.5% $CaCO_3$ according to Jimenez et al. (2008).After incubation at 37°C, in anaerobic atmosphere (Jar with Anaerogen 2.5L from Oxoid), the medium, by nutrient fermentations, produce organic acids which determine an area of clearance around the bacterial colonies.

The isolated strains were stored at -80°C, in MRS medium with 20% glycerol.

The taxonomic identification was performed by culturally, morphologically and biochemically tests (Raducanescu and Bica Popii, 1973). Isolated in pure culture, the bacterial strains were analyzed macroscopically, followed by morphology, consistency, type and contour of colonies, the presence or absence of pigments (Garrity et al., 2002).

Gram staining was used to distinguish Gram - positive from Gram-negative bacteria (Garrity et al., 2002).

Biochemical tests

The isolates were assayed by oxidase test which consist in the presence of cytochrome C-oxidase by used impregnated strips in N,N,N,N-tetra Methyl-PhenylenediamineDihydrochloride(TMPD)(Sigma)(www.tgw1916.net).

According to Sagar (2015), the catalase test was determined, as well. It showed the presence of catalase, an enzyme that catalysis the release of oxygen from hydrogen peroxide (H_2O_2). A concentration of 3% H_2O_2 was used.

The isolate was identified using the API 50 CHL strips according to manufacturer's protocol (BioMerieux, Marcy l'Etoile, France). The strips are read after 48-72h incubation at 37°C. The results performed the biochemical profile of LABs, which were identified with API 50 CHL V5.1 and ABIS online software (Stoica and Sorescu, 2017).

The capacity of synthesizing organic acids (lactic acid, phenyl-lactic acid, hydroxylphenyl lactic and acetic acid) was determined by High-Performance Liquid Chromatography HPLC (Surveyor Plus – Thermo - Electron Corporation, Waltham, MA). 2.0 ml of monoculture was dispersed on MRS broth with addition of $CaCO_3$ and harvesting the cells by centrifugation at 5000 x g for 5 min., to pellet precipitate. The supernatant was removed and debris suspension was re-suspended in 2.0 ml distilled water (DW) and from this volume, 50 µl was transferred to be used in column separation of the acids.

Colony forming unit count (CFU)

To assess growth rate, the *L. plantarum* was cultivated on MRS medium (broth and agar) and Malt extract medium (broth and agar), at 37°C, for 48 h. Successive replications were done to determinethe bacterial density at 48 h.

Assessing the enzymatic activity

It was used for development and production of enzymes biosynthesis by our isolated strains, a culture medium consisting of malt, soybean meal, milk substitute, molasses and water (Table 5, variant 1).

The enzymatic activity of strain's isolates was determined by the following methods: Hostettler for amylase activity, Petterson and Porath for celullase activity and Anson modified on casein substrate for protease activity (Dumitru et al., 2016).

Hostettler's method is based on the action of α-amylase on starch and determination of maltose released after the enzymatic hydrolysis process, with 3.5-dinitrosalicylic acid (DNS). The optical density (OD) of the sample was read at 546 nm, compared to the control. An amylase unit corresponds to a quantity of maltose (µmol) released in one minute under the action of 1 ml of enzyme preparation, at 30°C.

Petterson and Porath's method consists in the enzymatic hydrolysis of carboxymethyl-cellulose (CMC) and dosing of reductant groups released with 3.5-DNS. A cellulolytic activity unit represents the amount of enzyme which releases from a CMC solution, an amount of reducing carbohydrates, which form with the DNS reagent, the same OD, similar to a milligram of glucose (Dumitru and Jurcoane, 2017). OD of the sample was read at 640 nm.

Protease activity was determined by Anson method, modified on casein substrate. Method is based on the determination of tyrosine, resulting from the action of proteases on the casein substrate. In order to highlight the reaction product, was used Folin-Ciocalteu (FC) reagent, which forms a colored compound with tyrosine. OD was determined at 660 nm (Jurcoane et al., 2006).

Inoculum preparation of L. plantarum

Inoculum preparation at laboratory level

Tubes with MRS and malt extract medium (agar) were inoculated with lactic acid bacteria at 37°C, for 48 h. Successive passages were performed to determine the density of bacteria, until a yield of grows was reached.

In order to obtain the inoculum, several variants, based on natural medium (corn flour, malt natural medium, soybean meal, molasses and water) were prepared, which differed by the quantity of ingredients used (Table 1).

The amount of each version was calculated for 250 ml of water, dispensed in Erlenmeyer flasks of 500 ml, homogenized and sterilized 15 min., at 121^{o}C. For each variant was added molasse at source of carbon.

Table 1. Variants of medium for obtaining the inoculum

Ingredients % (w/v)	Variant 1	Variant 2	Variant 3	Variant 4
Malt	20	15	15	10
Soybean meal	2	2.5	2	2.5
Milk substitute	1	1	1	2
Molasses	2	2	2	2
Water	100	100	100	100

The natural medium was autoclaved 15 min., at 121°C. After cooling to 45-50°C, the medium was inoculated with the pure culture of 25 ml *L. plantarum* and incubated at 37°C, for 48-72 h.

Four successive passages were done to determine the concentration of lactic bacteria.

Inoculum preparation in Biotechnological Installation

The procedure development in the lab was performed in the Biotechnological Installation (IL 00) from INCDBNA Balotesti, following the biotechnological process steps.

For the all variants of medium, it was selected variant 1 (Table 1).

Corn flour was added, to increase the lactic bacteria numbers. The used culture medium consisted of 1000 g corn flour, 400 g soybean meal, 200 g milk substitute, 4000 g malt flour and 400 g molasses, at 20 L of water. All ingredients were homogenized, sterilized by autoclaving, at 110°C, 1 h. After cooling to 40-45°C, the mixture was transfused in the fermenter, over which was added 2 L of inoculum. The inoculated medium was stored in the fermenter at 35°C, for 72h. To reduce the moisture content, the product was mixed with 6 kg of wheat bran.

The optimum level of feed additive obtained will be established in weaned piglet's diet, as well.

RESULTS AND DISCUSSIONS

Three LAB strains were isolated from gastrointestinal tract of healthy piglets and analyzed. The samples were purified by passing on MRS agar supplemented with 0.5% $CaCO_3$. After purification, the strains were stored at -80^{o}C in MRS broth with 20% of glycerol.

Cultural characteristics

The isolated strains were presumptively identified as lactobacilli. It presents the ability to grow on MRS medium + 0.5% $CaCO_3$. The colonies appear white, cream, translucent, with regularly shaped and smooth surface and produce a clear zone around, as a result of the release of organic acids, that degrade $CaCO_3$ (Figure 1).

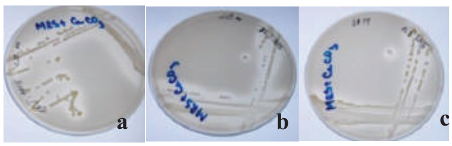

Figure 1. The *Lactobacillus* colonies on MRS agar + $CaCO_3$ (a. *L. plantarum*; b. *L. acidophilus;* c. *L. paracasei*)

The isolates are facultative anaerobic. In the MRS broth medium was noticed an intense turbidity, with abundant deposits, without surface formations.

Morphological identification

Gram-positive rods with rounded ends (0.7-0.9 x 1.2-1.5 μm), was measured by Zeiss Microscope which presents gradation on the eyepiece. Mostly of the colonies have convex form, appear structures of coccobacilli and bacilli in short and long chains, non-spore forming, non-motile (Figure 2).

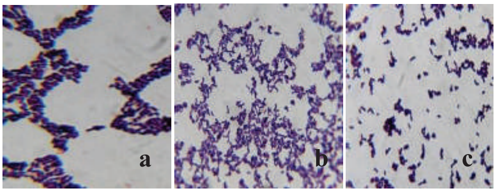

Figure 2. The morphological identification of *Lactobacillus* spp.
(a. *L. plantarum;* b. *L. acidophilus;* c. *L. paracasei*)

Biochemical characters

The isolated strains produced negative results in the catalase and oxidase tests.

The strains were identified and characterized using the bioMerieux API 50 CHL test kit. This kit consists of 49 tests and is based on the capacity to metabolize 49 different carbohydrates (Figure 3).

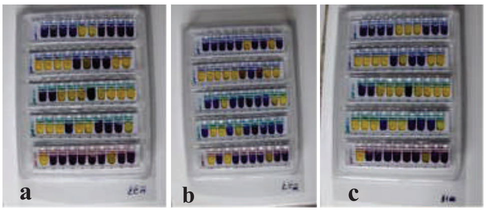

Figure 3. API 50 CHL strips inoculated with *Lactobacillus* spp. (a. *L. plantarum;* b. *L. acidophilus;* c. *L. paracasei*)

According to the fermentation profile, the isolates were identified as *L. plantarum*, *L. paracasei* and *L. acidophilus* with a percentage of 93%-95% (Table 2).

Table 3 presents the results from the preliminary conventional taxonomic analysis of LABs strains.

Table 2. The results obtained with API 50 CHL test for *Lactobacillus* spp. based by biochemical fermentation

Item	*L. plantarum*	*L. paracasei*	*L. acidophilus*
Glycerol	–	–	–
Erythritol	–	–	–
D-arabinose	–	–	–
L-arabinose	–	–	–
D-ribose	+	–	+
D-xylose	+	+	+
L-xylose	–		+
D-adonitol	–	–	–
Methyl-βD-xylopyranoside	–	–	–
D-galactose	–	+	–
D-glucose	+	–	+
D-fructose	+	+	+
D-mannose	+	+	+
L-sorbose	-	+	+
L-rhamnose	±	+	–
Dulcitol	–	+	+
Inositol	–	±	–
D-mannitol	+	–	–
D-sorbitol	+	±	+
Methyl-αD-mannopyranoside	–	+	+
Methyl-αD-glucopyrano side	–	+	–
N-acetylglucosamine	+	–	–
Amygdalin	+	–	+
Arbutin	+	+	+
Esculin	+	–	+
Salicin	+	–	+
D-cellobiose	+	+	+
D-maltose	+	–	+
D-lactose	+	–	+
D-melibiose	+	+	+
D-saccharose	+	+	+
D-trehalose	+	–	+
Inulin	–	+	+
D-melezitose	+	+	–
D-raffinose	+	–	+
Starch	–	+	+
Glycogen	–	–	–
Xylitol	–	–	–
Gentibiose	+	–	–
D-turanose	+	–	+
D-lyxose	–	+	+
D-tagatose	–	–	–
D-fucose	–	+	–
L-fucose	–	–	–
D-arabitol	–	–	–
L-arabitol	–	–	–
Potassium gluconate	+	±	±
Potassium2-ketogluconate	–	–	–
Potassium5-ketogluconate	–	–	–

Table 3. Results of preliminary taxonomic analysis

Item	Strain 1	Strain 2	Strain 3
Gram staining	+	+	+
Catalase test	-	-	-
Peroxidase test	-	-	-
API 50 CHL	*L.plantarum*	*L.paracasei*	*L. acidophilus*

The ability to synthesize organic acids (lactic phenyl-lactic, hydroxyphenyl-lactic and acetic) was tested, as well (Table 4).

Table 4. Evaluation of the capacity of the synthesis organic acids

The strains	Lactic acid (g/l)	Phenyl lactic acid (g/l)	Hydroxi phenyl lactic acid (g/l)	Acetic acid (g/l)
L. plantarum	5.83	0.01	0.00	0.25
L. paracasei	3.50	0.00	0.00	0.20
L. acidophilus	6.40	0.02	0.01	0.45

The ability to synthesize organic acids differs in the various strains (Figure 4).

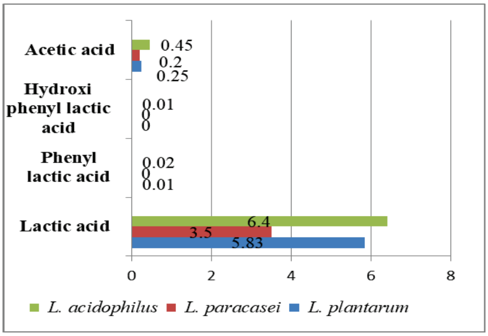

Figure 4. Optimal quantity of organic acids produces by LABs strains on Oxoid MRS medium supplemented with 0.5% $CaCO_3$

L. acidophilus presents the highest level to produce lactic acid (6.40 g/l) compared to *L. plantarum* (5.83 g/l). The minimal quantity of lactic acid is produced by *L. paracasei* (3.50 g/l). Also, the *L. acidophilus* produces acetic acid (0.45 g/l) compared to *L. paracasei* and *L. plantarum*. None of the isolated strains had the capacity to produce hydroxyphenyl and phenyl lactic acid.

According to the specialty data (Okorhi, 2014), the results obtained were classified based on quantities produced by the majority of LABs which was assessed for each type of acid (lactic acid 2.9-7.8 g/l, phenyl-lactic acid 0-0.05 g/l; hydroxyphenyl-lactic acid 0-0.22 g/l; acetic acid 0-0.65 g/l).
The isolated strains didn't have the capacity to produce exogenous enzymes (amylases and proteases) (Table 5).

Table 5. The enzymatic activity of isolate strains

The strains	Amilolytic activity	Celulolytic activity	Proteolytic activity
L. plantarum	0	1.5	0
L. paracasei	0	0.34-0.35	0
L. acidophilus	0	0	0

Regarding to the production of cellulase enzyme, *L. plantarum* shows a cellulolytic activity of 1.5 (U DNS/ml), compared with *L. paracasei* which had a low cellulolytic activity of 0.34-0.35 (U DNS/ml).
L. plantarum possesses some probiotic property and was selected for the next steps. The isolate registred the capacity to synthesis organic acids (5.83 g/l lactic acid and 0.25 g/l acetic acid) and a cellulolytic activity of 1.5 (U DNS/ml).
The development of *Lactobacillus plantarum* was assessed on 4 variants of culture media containing different concentrations of ingredients (corn, soybean meal, substitute of milk) (Table 1). Variant 1 presents the highest density (1.05 x 10^{10} CFU/ml), compared to variant 2 (6.5 x 10^{9} CFU/ml), variant 3 (8.5 x 10^{9} CFU/ml), respectively the last variant of medium (5.5 x 10^{9} CFU/ml).
It was selected the first variant to manufacture the product at biorector level in the Biotechnological Installation (IL 00).
The obtained product was packaged in polyethylene bags and stored at 18-20°C (Figure 5). The finished product has a characteristic smell of lactic acid, sour taste and a concentration of 1.5 x 10^{11}CFU/g.
The production of lactic acid after fermentation process was determined and a similar value, compared with the quantity of organic acids produces by *L. plantarum* strain was detected.
The final product has been stored for a period of 3 weeks. The concentration of LABs from product storage was determined in this time.

Figure 5. Biotechnological product based on *L. plantarum* strain

In the first week, we noticed a slight increase of lactic bacteria numbers (1.75 x 10^{11}CFU/g), compared with the second week, when was registered a decrease of this (1.35 x 10^{11}CFU/g). In the last week, the lactic bacteria were around 9.5 x 10^{10}CFU/g. This decrease is due to the loss of bacterial viability which defined the ability of bacterial cells to form colonies on selective medium agar in suitable conditions (Figure 6).

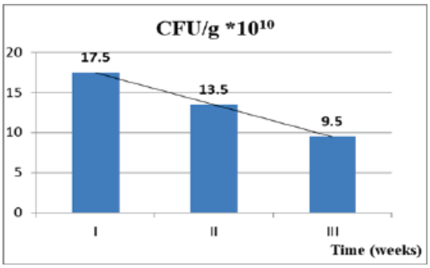

Figure 6. The concentration of bacteria time of 3 weeks in product storage

Lactobacillus spp. has been reported as one of the major bacterial groups from gastrointestinal tract of pigs (Dibner and Richards, 2005).

CONCLUSIONS

The carbohydrate fermentation tests using API 50 CHL kit was used to identify some species of lactic acid bacteria isolated from gastrointestinal tract of piglets. The isolated strains were identified as *L. plantarum, L. paracasei* and *L. acidophilus*.

From the all strains, *L. plantarum* was selected to be further assessed as feed additive in swine nutrition.

The ability of lactic acid bacteria to produce organic acids was tested, *L. plantarum* registered 5.83 g/l. The enzymatic activity level of *L. plantarum* compared with *L. paracasei* and *L. acidophilus* shows a cellulolytic activity of 1.5 (U DNS/ml).

The results suggest that *L. plantarum* strain had some probiotic traits and can be further assessed for other characteristics (resistance to pH 2.0, resistance to bile acids and salts, antibacterial activity, induction of local immune response etc.), in order to evaluate its probiotic utility in pigs nutrition.

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CHALLENGES REGARDING THE RECENT EVOLUTION OF NATIVE LIME TREE SPECIES IN THE MANAGED FORESTS OF CARANSEBEȘ AREA, WESTERN ROMANIA

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Abstract

The total forest area in Romania has been sustainably managed based on ten years plans for more than 50 years. Tilia sp. (lime tree species) area in Romanian forests covered around 214,000 ha in 1966 (1% of the total forest area) but recent data show that the lime - tree species proportion has easily been increasing in the last decades. From the 40 genera and over 350 species of the Tilliaceae family that are spread especially in the tropical and subtropical regions, in Western Romania the lime tree species are represented by three native species of the same Tilia genus: Tilia cordata Mill., Tilia tomentosa Moench. and Tilia platyphyllos Scop. Data from the national forest inventory, data from succesive forest management plans for the period 1968-2016 and recent field research data from Western Romania were analysed. The research studies and official reports from the region present lime-tree species as resistent to abiotic (draught, pollution) and biotic stress (no important parasite or disease of Tilia sp. has been reported in the Western part of Romania). An interesting situation is presented in Caransebes area, in the same region. Recent data analysis shows that in this area, the lime-tree species have maintained or even increased their total area in spite of all silvicultural management measures which were performed in the last decades in accordance with the management plans stipulations and which have favoured the beech, oak or coniferous species against the lime trees. The lime tree ecological demands and also its reproductive systems (both vegetative and sexuate) seem to be a competitive advantage in the present-day climate change local context. The future forest management planning activities should consider adequate measures to use the lime-tree species competitive advantage in order to promote a sustainable forest management in the region. The aesthetic species wood qualities and their numerous uses in wood industry are also very important arguments in this respect.

***Key words**: forest management plans, silvicultural management measures, climate change, species competitive advantage.*

INTRODUCTION

The total forest area in Romania has been sustainably managed based on ten years plans for more than 50 years. The first Management Plan for the Forest District Caransebeş was elaborated in the year 1954 and after that in the year 1968, 1978, 1986, 1996, 2006 and 2016 (National Institute for Research and Development for Forestry „Marin Drăcea", 2016). We only analyzed the period 1968-2016 because in the year 1974 the forest district was split up and from then the surface of forest is relative constant at 18500 ha. After the year 2006 the Experimental Basis Caransebeș (EBC) (current name) of National Institute for Research and Development for Forestry „Marin Drăcea" has restituted to the former owners approximate 1000 ha of forest from which 546.7 ha from Forest Unit I (compartment 1-8,11-13A, 30A-34,36,37,43) were *Tilia* genera species were very well represented.

Lime trees are important species covering large areas in the forests administrated by the EBC. Especially *Tilia tomentosa* Moench., silver lime but also *Tilia cordata* Mill., and *Tilia platyphyllos* Scop., lime trees found here a large altitudinal amplitude, from plain and hilly area to the mountain areas, and as a consequence EBC is the right place in the western Romania, where the natural distribution of lime trees can be studied in order to observe the specific requirements and the extension tendency of this species.

In terms of lime trees importance for the forest ecosystems and soil properties, various research found that lime is related to a considerably higher pH, base saturation, base cation and boron pools comparing to spruce, which determined the most acidifying effect on the mineral top soils (Hagen-Thorn et al., 2004).

Regarding the sdudied area, EBC is situated in the western Romania, on the western part of Poiana Rusca Mountains, western part of Muntele Mic and Tarcu mountains, and also on their prolonges until to Timis river on his right part (National Institute for Research and Development for Forestry „Marin Drăcea", 2016).

The research area considered for the present study is located between the follow geographical coordinates: $44^0$57'-$45^0$17' nordic latitude and $22^0$30'-$22^0$52' estic longitude.

For a good understanding of site conditions for EBC forests, we need to specify that the altitude varies from 200 to 1600 m and the average temperature is 11°C in Timis river lowland area (meteo station Caransebeş), decreasing to the mountain area, to 4°C at meteo station Muntele Mic at the altitudinal limit of forest.

The extremes of averages temperatures variate in a limit of 7°C (a gradient of 0.44°C/100 m of altitude) (National Institute for Research and Development for Forestry „Marin Drăcea", 2016).

Forests of EBC are situated on partly sunny sides with slopes more than 30°C in many cases, or even steepness, with soils on poor rocks, harsh, acidic, dominating as deep being superficial to medium soils (National Institute for Research and Development for Forestry „Marin Drăcea", 2016).

Regarding lime trees distribution and the type of soils in the research area (Caraş-Severin County, were the EBC is located), the repartition of forest soil types from this county is similar with the distribution in the entire country (the first place is occupied in both cases by dystric cambisol, while the participation percentages of luvisol and preluvisol are similar).

However, they are different regarding the presence of eutric cambisol (much higher in this County comparing n with the country average level).

This fact is caused by the massive presence in this County of inferior premontane-mountain areas, occupied by beech stands, areas specific to this type of soil (Dincă et al., 2017).

MATERIALS AND METHODS

In order to achieve the research objectives presented above, there were performed the following *a bibliographic research and documentation*, data from succesive forest management plans for the period 1968-2016 and data from national forest inventory; observations in the field on a determined itinerary to identify the the presence/absence of lime species on different previously established check areas; analysis of lime trees distribution and recent field research data from Western Romania were analysed.

The research area consists of 17733 ha of natural forest from which 655 ha are lime forest located in the Western part of Romania, Caraş-Severin County, Caransebeş area.

RESULTS AND DISCUSSIONS

The lime tree species had a steady representation over the last 50 years in the Forestry Unit (F.U.) I, II, III of the EBC. The percentage of participation in the total research area (all 7 F.U. of the EBC) is 4% (Table 1), but in the F.U. I percentage is 17%, in F.U. II is 10% and in F.U. III the percentage of lime is 6% (National Institute for Research and Development for Forestry „Marin Drăcea", 2016).

Table 1. The structure of lime forests in research area Caransebeş (EBC) 1968-2016

Year	1968	1978	1986	1996	2006	2016
Lime in the forest stand species composition %	4	4	4	4	4	4
Site class	II, 6	II, 3	II, 3	II, 4	II, 8	II, 9
Crown density	0.91	0.83	0.83	0.83	0.82	0.8
Age years	43	60	60	67	73	78
Current annual increment m^3/year/ha	4.0	8.4	8.4	7.6	6.7	5.5
Volume 1000 x m^3	271	200	195	214	218	215
Average volume m^3/ha	254	297	297	318	319	329

Starting with the year 1974 many forest stands called compartments (Co.) were undergoing definitive cuts as management options. Concidering „The national programe for resinous wood in this compartments were planted resinous wood to raise the value of the forest. For planting the following species were used: Douglas fir, *Pinus* spp., Norway spruce, European silver fir and European larch. As a result of analyses of Forest Management Plans and after that the field work revealed that nowadays the native species (lime, beech, sessile oak, hornbeam) have returned in their natural range of the research area.

Because the lime-tree species have a good capacity to sprout and suckering and being a faster growing species they reconquered their initial territory.

As can be seen from Table 2 after the Management Plans from the year 1978 the surface covered by *Tilia* sp. decreases because of the definitive clear cuts, but after the year 1986 the surface grows steadily.

In the same table we can see that the origin of lime tree species is 81% from shoot and only 19% from seed.

After the bibliographic analysis some observations in the field were performed considering the most interesting cases (13 compartments in Table 3).

Table 2. Lime tree evolution in Caransebeș region between 1968-2016

Lime	Surface				Productivity				Proportion			Origin		Vitality	
	Total ha	%	Group I ha	%	Sup %	Med %	Inf %	Med	50	50-80	80	Seed %	Shoot %	Good %	Weak %
1968	803.0	4	192.5	20	100	0	0	100	74	21	5	6	94	100	0
1978	638.8	4	11.7	-	66	33	1	86	79	18	3	8	92	99	1
1986	657.4	4	55.0	9	58	41	1	83	74	24	2	10	90	97	3
1996	671.4	4	86.3	13	61	39		83	75	21	4	12	88	99	1
2006	683.2	4	97.4	14	21	77	2	83	75	22	3	7	93	96	4
2016	655.3 (729.2)*	4	187.34	29	14	86		80	79	20	1	19	81	97	3

*After the year 2006 the Experimental Basis Caransebes (actual name) give to former owners approximate 1000 ha of forest from wich 546.7 ha from Forest Unit I (compartments 1-8,11-13A, 30A-34,36,37,43) were *Tilia* species were very well represented.

Table 3. Species Evolution in selected compartments (Co.) of the research area Caransebeș between 1968-2016

Year / F.U./Co.	1968	1978	1986	1996	2006	2016
I/13B	4Li3Se2Be1Ho	4Li3Se2Be1Ho	6Do2Se1Be1Sy	5Do2Se1Be1Sy1Ho	2Li2Do1Se2Be1Sy2Ho	2Li1Do1Se2Be1Sy1Ho
I/14A	3Li3Be3Ho1Hw	4Li3Be2Ho1Se	7Do1Pi1Be1Sy	7Do1Pi1Be1Sy	2Li5Do1Be2Ho	2Li5Do2Be1Ho
I/15A	1Li7Be1Se1Ho	7Do3Pi	6Do3Pi1Be	1Li4Do1Pi2Be2Ho	2Li3Be3Ho1Hw1Dr	2Li3Be3Ho1Hw1Dr
I/16	2Li5Be2Ho1Se	10Do	8Do1Be1Ho	7Do2Be1Ho	3Li1Do4Be2Ho1	2Li6Be2Hw
I/28A	3Li3Be3Ho1Se	7Do3Sy	4Do2Sy2Be2Ho	1Li3Do2Sy2Be2Ca	2Li4Be3Ho1Dr	2Li4Be3Ho1Dr
I/29	3Li4Be2Ho1Se	3Do3No2Si2Hw	3Do2No1Si3Be 1Se	1Li3Do2No1Si1Be1 Ho1Se	2Li3Be3Ho1Se1Dr	2Li3Be3Ho1Se1Dr
I/30B	3Li3Ho2Be1Se	3Do6Si1Sy	3Do5Si1Sy1Hw	2Li2Do4Si1Sy1Hw	3Li2Do2Si1Sy2Hw	3Li2Do2Si1Sy2Hw
II/59A	5Ho4Be1Tu	7Ho2Be1Tu	7Do1Pi	1Li2Do2Pi1Be1Ho3 Hw	1Li2Do2Pi1Be1Ho3Hw	1Li4Do3Ho2Hw
II/60A	6Ho2Be2Tu	10Pi	9Pi1Hw	2Li4Pi1Be2Ho1Hw	1Li4Pi2Be1Ho2Hw	1Li4Pi1Be2Ho2Hw
IV/10A	6Se2Be2Tu	6Se1Be3Tu	7Pi1Do1La1No	4Pi1Do1La2No2Be	1Li3Pi2No1La1Be1Ho1 Se	1Li2Pi1No1La1Be1Ho2 Se1Hw
IV/11A	10Be	10Be	2La2No1Pi2Se1 Sy3Hw	1Li2La2No2Pi1Se1 Sy1Be	1Li1La1No1Pi1Se1Sy4 Be	1Li1La1No1Pi1Se2Ho1 Tu2Be
IV/11C	10Be	10Be	10Be	8No1Pi1Sy	1Li5No1Pi1Sy1Be1Ho	1Li4No1Pi1Be2Se
IV/11F	10Be	10Be	10Be	1Li1Be2No2Pi2Se1 Sy1La	1Li2Be2No2Pi1Se1Sy1 La	1Li2Be1No1Pi2Se1La2 Ho

Li=Lime, Se=Sessile oak, Be=Beech, Ho=Hornbeam, Do=Douglas fir, Sy=Sycamore, Hw=Different hard wood, Pi-Pinus sylvestris, Dr=Different resinous, No=Norway spruce, Si=Silver fir, Tu=Turkey oak, La=Larch

From the selected cases we can see that we have two situations: one in the F.U. I in the Co. 13B, 14A, 15A, 16, 28A, 29, 30B where before 1968 *Tilia* sp. was present and the other one in F.U. II Co. 59, 60 and F.U. IV Co. 10A, 11A, 11C, 11F where this species was not present before. The both situations area analysed as follows.

In the Co. 13B where the species composition in the year 1968 was 4Li3Se2Be1Ho in the year 1978 were made clear cuts and big wood volumes were harvested: No 10 m^3, Be 900 m^3, Se 2070 m^3, Hw 540 m^3, Li 3410 m^3. One year after that afforestation with 60%Do40%Sy was performed. After that in the next two Forest Management Plans (F.M.P.) *Tilia* sp. is no

longer mentioned, but in the F.M.P 2006 lime trees appear again with 20% from stand composition, situation maintained in 2016.
The situation is almost the same in Co. 14A where in 1979 after clear cuts a large wood volume was extracted: Be 850 m^3, Se 780 m^3, Hw 410 m^3, Li 1310 m^3 and in 1980 they planted 70%Do20%Sy10%Pi and after that only in the FMP 2006, the lime tree species appear with 20% in the stand composition and the situation has been maintained until 2016.
In the Co 15A a clear cut was performed in 1975 and this stand was planted in 1976 with70%Do30%Pi. After 20 years in F.M.P. 1996 lime species cover 10% and starting 2006 until 2016 was extended to 20%.
In the compartment 16 clear cuts were made earlier in 1975 and in 1976 the afforestation was made with 100%Do. After 30 years, in 2006 lime tree species appear with 30% but after a thinning in 2016 lime percentage in stand composition is 20.
In 28A Co. I, in the year 1974, the forest was clear cut and in the next year was with 70%Do30%Sy planted. After 20 years, in 1996, the lime species show up with 10% which grows in 2006 grows at 20%.
In Co. 29 with a total surface of 57.5 ha, the biggest compartment in the research area, is definitive cuts were performed followed in 1975 by plantations with: 40%No30%Do30%Si. Records show in the F.M.P. 1996 that *Tilia* sp. has 10% and grows at 20% in 2006, situation unchanged in 2016.
In Co. 30B definitive cuts were performed in 1974 and the afforestation was made in 1975 with 60%Si30%Do10%Sy. As a result, in the year 1996 *Tilia* sp. covered 20% and from 2006, until 2016, 30%.
There were situations where before performing clear cuttings *Tilia* sp. was not present but appeared after the afforestation.
In Co. 59A from F.U. II a definitive cut was performed in 1982 and next year in 1983 afforestion was made with 70%Do30%Pi. In the next F.M.P in 1986 *Tilia* sp. was present with 10% and it remained similar from 1996, 2006, 2016.
Also, in Co. 60A, where clear cuts were made in the year 1974 and in 1975 afforestation with 100%Pi was performed. Again in the year 1996, lime tree appear with 20% but after the thinning only 10% remained.
In the compartment 10A from F.U. IV, in the year 1984 clear cuts was done and the wood harvested volumes were in m^3: Be 190 m^3, Se 1920 m^3, Hb 10 m^3. The afforestation was made with 70%PI20%La10%Do. In the F.M.P. 2006 lime trees have had 10% in the forest stand composition and in 2016 is similar situation.
From Co. 11A in the year 1983 were harvested 5720 m^3 of beech and the afforestation was performed with 20%La20%No10%Pi40%Sy. After 10 years, in 1996 *Tilia* sp. appeared with 10% and it remains similar till nowadays.
In Compartment 11C afforestation was done in the year 1986 with 80%No10%Pi10%Sy but in the F.M.P from 2006 until 2017 lime has been present with 10%.
Compartment 11F from F.U. IV was totally clear cut in 1986 and the harvested volumes were: Be 3940 m^3, Se 480 m^3, Hw 90 m^3, Sw 50 m^3. Afforestation was made with 80%Pi20%No but since 10 year later, in 1996, lime has been present covering 10% of the forest stand.
Noumerous similar situations were observed in different forest areas from Western Romania by the authors.

CONCLUSIONS

As we can see from Table 3 in the F.U. I in compartment 13B, 14A, 15A, 16, 28A, 29, 30B after the definitive cuts and afforesting with different resinous species (Douglas fir, Scottish pine, Norway spruce, silver fir, larch and with sycamore). The autochthonous trees (Lime Sessile oak, Beech, Hornbeam) have reclaimed their territory very fast (10-30 years for the lime). This can happen because lime-tree species have a good capacity to sprout and suckering and being a faster growing species they reconquered their initial territory.
According to Spârchez et al. (2011), the anthropic causes that led to the degradation of the stands are: applying the cuts in simple groves, the consequence being the reduction of the biodiversity and the extension of common hornbeam, lime tree and other mixture species to the detriment of common oak species, which leads to as called „derived stand”.

Situation is different in the compartment 59A, 60A from F.U. II and Co. 10A, 11A, 11C, 11F from F.U. IV, where lime was not present before. Otherwise in the Forest Unit IV *Tilia* sp. appear starting up from 1996 in co. 10A, 11A, 11F, 57C, 64, 75. In 2006 lime covered 50 ha and in 2016 it raised to 61 ha approximate 2% from the total surface of F.U. IV.

The average age of one compartment where lime is present is usually between 25-80 years, and as a conclusion after the cutting of the initial forest stand, the lime use to find an opportunity to spread in the opened space after the cuttings on large areas.

The present study supports the opinion of various researchers which consider that some species, including lime but also oak, as well as pioneering birch and aspen, seem to regenerate in a discrete and irregular manner. It was hypothesised that their regeneration depends on ephemeral opportune circumstances occurring at the initial phase of gap filling, such as presence of layering fresh logs, sprouting stumps and roots, spots of exposed mineral material, as well as inaccessibility to browsers (Bobiec, 2007).

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THE COROLOGY, ECOLOGY AND PHYTOSOCIOLOGY OF THE 91I0 FOREST HABITAT FROM THE DANUBE VALLEY, BETWEEN CIUPERCENI AND GHIDICI SETTLEMENTS, DOLJ COUNTY

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Abstract

The thematic area provided in this paper is situated in the Danube Valley, between the settlements Ciuperceni and Gidici, Dolj County. This area is studied in the Bailesti plain, on the fifth terrace of Danube, part of the Oltenia Plain. Throughout the protected area is under the continental climate with Mediterranean influences. Since geologically in this area meet recent alluvial deposits represented by carbonate sands and sandy deposits of wind origin. In this territory the biodiversity is very rich, the studied area including the protected area of community importance - ROSCI 0039 Ciuperceni-Desa. The most important habiat forest is 91I0 - Euro-Siberian steppic woods with Quercus spp. This habitat is edifies by Quercetum roboris balsicum Paun (1964) 1966 (Syn. Festuca rupicolae-Quercetum roboris Soó (1934) 1937) palnt community that we found in the Arceru (Oveaselor) and Buricliu forest. The forests from this area benefits from the contribution of groundwater, compensate for the lack of water from rainfall and low levels of nutrients in the soil.
Considering the place where the study had been located to, the eco-pedo-climatic conditions and the anthropic term exerted we have considered that is necessary to develop some ecological studies (and using statistical methods (UPGMA and WPGMA, STYN-TAX 2000) for the plants communities of the forest habitat from this area.

Key words: *forest habitat, plant communities, Danube Valley.*

INTRODUCTION

The territory under research is located along of the Danube Valley, part of the Southern of Oltenia, tanging between Ciuperceni and Ghidici settlements.
The natural habitats of this region in Romania are very rich and interesting. The relief, climate and soil types determine a raised diversity of the vegetal species, plant communities, habitats, and landscapes in this area.
The studied area contains a significant number of rare or vulnerable species, included in the European or National Red Lists. The present paper aims presenting one forest habitat 91I0 - Euro-Siberian steppic woods with *Quercus* spp., met in the Arceru (Oveaselor) and Buricliu forest from Dabube Valley.
The forests from this area benefits from the contribution of groundwater, compensate for the lack of water from rainfall and low levels of nutrients in the soil. The vegetal carpet of this forest habitat contains many species characteristic of the Danube Valley.

MATERIALS AND METHODS

The analysis of the palnt community was done using the method of the Central - European phyto-coenological school. For the plant community we have calculated the *Bray-Curtis* indices using the medium species abundance-dominance value (Podani, 2001). In order to identify the species and the inter-taxa, we looked into: *Romanian Flora*, vol. I-XII (1952-1976); *Flora Europaea*, vol. I-V (1964-1980).
The basic coenotaxonomic unit which was used to study the vegetation was the vegetal association. The associations were identified and distinguished according to the characteristic, edifying, dominant and differential species and for the classification of this plant community, we have used synthesis papers elaborated by: G. Coldea (1986, 1991) and L. Mucina et al. (2016).
As for the identified of the habitat we have used synthesis papers on the Romanian Manual for interpretation of EU habitats and Council Directive 92/43/EEC of 21 May 1992 on the

conservation of natural habitats and of wild fauna and flora, Annex I (Habitats Directive).

RESULTS AND DISCUSSIONS

According to the research carried out between 2016-2017, in the Danube Valley, between the settlements Ciuperceni and Gidici, Dolj County, there were identified one plant community: *Quercetum roboris balsicum* Paun (1964) 1966 (Syn. *Festuca rupicolae-Quercetum roboris* Soó (1934) 1937).

This plant community edifies the forest habitat 91I0 - Euro-Siberian steppic woods with *Quercus* spp.

Corology: The phytocoenoses of the plant community of this forest habitat are situated in the *Arceru (Oveaselor) and Buricliu forests* developed on alluvial soil.

Physiognomy and floristic composition. In the phytocoenotic composition of this plant community, apart from species *Quercus robur*, there are also constant many species that belong to the coenotaxa: QUERCETEA PUBESCENTI-PETRAEAE (Oberd. 1948) Jakucs 1960, ACERI TATARICI-QUERCION Zólyomi et Jakucs 1957. In the phytocoenotic composition of this plant community, beside the dominant species *Quercus robur*, there are also: *Vincetoxicum hirundinaria, Scilla bifolia, Viola odorata, Asparagus tenuifolius, Astaragalus glycyphyllos, Viola suavis, Anthriscus cerefolium, Ornithogalum pyrenaicum, Carex michelii, C. tomentosa, Viola alba, Festuca rupicola, Urtica dioica, Helleborus odorus, Anemone nemorosa, Ranunculus ficaria, Verbascum phoeniceum, Carex remota, Silene alba, Geranium phaeum, Phytolaca americana, Lathyrus vernus, L. nissolia, Glechoma hirsuta*.

The coverage of trees is poor 50-65%. The herbaceous and bush cover layer are developed.

Threats to these phytocoenosis are the alien invasive plants: *Ailanthus altissima* and *Phytolaca americana* developed excessive (Figure 1).

They were also examined according to their floristic composition and physiognomy, syndynamics and economics. We paid much attention to the determination of the Bray-Curtis quantitative index (Figure 2), Kulczynschi symmetric index (Figure 3), Sørensen qualitative index (Figure 4), using the Group-Average method (UPGMA), and Jaccard index (Figure 5), using the WPGMA method and the achievement of dendrograms, using the program SYN-TAX 2000 (for the associations with minimum 10relevées).

Figure 1. *Ailanthus altissima* in the forest habitat 91I0

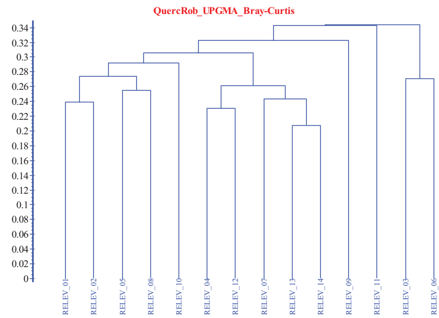

Figure 2. Bray-Curtis quantitative index

In the UPGMA dendrogram, using the Bray-Curtis index for this forest plant community, there are pointed out also 2 distinct clusters. In the first sub-cluster there are grouped relevées 1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13 and 14, especially due to *floristic*.

The latter clusters'surveys are grouped the relevées 3 and 6 - on high dominant values, due to the abundance of *Scilla bifolia* (abundance-dominance (AD) 2).

Given this dendrogram, the values of the quantitative index, *Bray-Curtis* varies, reflecting the heterogeneity of the floristic structure of the phytocoenoses of this pant community (Figure 2).

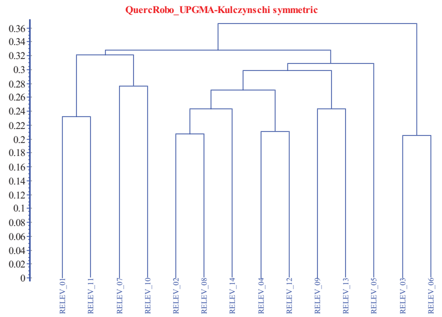

Figure 3. Kulczynschi symmetric index

The dendrogram made using the Group-Average method (UPGMA) and the Kulczynschi symmetric index, highlights the separation of two distinct clusters, which, as it can be observed quantitative index values are very close. In the first cluster we can notice the separation of the survey 5 based on the present of the species *Viola alba*, absent in all the other surveys (Figure 3).

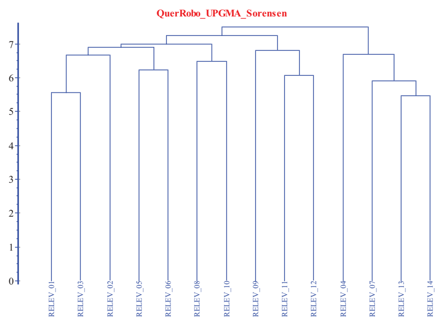

Figure 4. Sørensen qualitative index

After an analysis of the dendrogram (Figure 4) of this plant community, used WPGMA method and Sørensen qualitative index, there can be noticed the separation of the 4th, 7th, 13th and 14th surveys, from the rest of the surveys, which are grouped in a cluster, based on the presence of the species *Crataegus monogyna* in larger numbers of individuals, compared to other surveys.
WPGMA method and Jaccard index, there can be noticed the grouped of the 2th, 3th, 4th, 5th, 6th, 8th, 9th 12th, 13th and 14th surveyings, from the rest of the surveys, based on the similarity of the phytocoenosis (Figure 5).

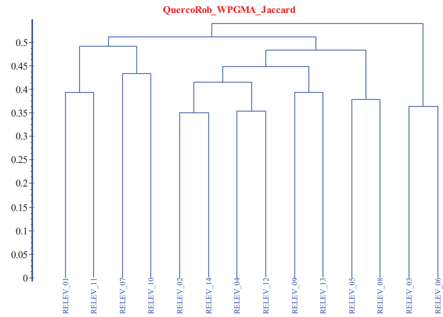

Figure 5. Jaccard index

CONCLUSIONS

The forests grow on large areas in Oltenia. They have a great importance in terms of biodiversity, but they also have a eco-pedo-genetic and economics role. In the researched area, the most important forest plant community is *Quercetum roboris balsicum* Paun (1964) 1966 (Syn. *Festuca rupicolae-Quercetum roboris* Soó (1934) 1937).
Threats to these phytocoenosis are the alien invasive plants: *Ailanthus altissima* and *Phytolaca americana* developed excessive.
The phytodiversity of this plant community and forest habitat from Southern of Oltenia is endangered because the human impact is very high, although this area it is included in the important protected area from Romania. Nowadays, great efforts are made to restore representative *Quercus robur* plant community and keep them in a favorable preservation state.

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UPDATED CHECKLISTS OF PLANT AND INSECT SPECIES OF ILGANII DE SUS (TULCEA COUNTY, ROMANIA)

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Abstract

Floristic and terrestrial insect checklists were compiled following the biological exploration of Ilganii de Sus area, Tulcea County (September 2017) and - which is valid only for plants - according to the already published literature, especially the monograph of the above-mentioned village. We report the species in an alphabetical order of the genera, then of species within the genera. The plant habit (herb, shrub or tree) is also mentioned for each record of vascular flora. Summing up all data sources, of the 135 plant species, 11.11% belongs to Asteraceae, 8.15% to Fabaceae, 5.92% to Salicaceae and the rest to other families. Coleoptera was found to be the leading taxa in the analyzed sample of 28 insect species. The present report brings a contribution to the actual state of knowledge about plant and arthropod species listed for Ilganii de Sus, a settlement from Danube Delta Biosphere Reserve.

Key words*: species checklists, Danube Delta, Ilganii de Sus, sampling, plant, insect.*

INTRODUCTION

Ciocârlan (2011) drew attention to the richness of species in the wild flora characteristic of the Danube Delta.
In spite of few research papers that have reported some flora and fauna species for Ilganii de Jos and Ilganii de Sus, there is currently no available information about more accurate checklists of plant or insect species only for Ilganii de Sus.
Ilganii de Sus is a village from Maliuc commune (Tulcea County), located on the left shore of Sulina Branch. Along with other localities like Partizani, Vulturu, Gorgova, Crişan and Caraorman, Ilganii de Sus is part from apiarian rout no. 4 with melliferous potential in Danube Delta Biosphere Reserve (D.D.B.R.) (Covaliov et al., 2012). With respect to biodiversity, Moţoc and Manole (2015) have made an extensive documentation in the monograph of Ilganii de Sus and Partizani (the village from the opposite side of Sulina Branch). In a previous study (Dobrin et al., 2013), we mentioned a list of plant and associated insect species encountered in Ilganii de Jos, Nufăru commune, on Sfântu Gheorghe Branch. Since both villages are protected localities on the territory of D.D.B.R., the aim of this study was to collect and identify new biological material in order to contribute to the current state of knowledge concerning the floristic and invertebrate biodiversity of these close regions.

MATERIALS AND METHODS

The selected areas for collecting both plants and insects at Ilganii de Sus, Tulcea County ranged from 45°11′31.60″N/28°56′1.59″E and 45°11′39.83″N/28°58′10.33″E geographical coordinates, along Sulina branch of the Danube and Arhipenco channel. The chosen habitats for sampling biological material included grazing meadows, floodplains, forest plantations, sandy shores or ruderal areas on the country road (Figure 1).
Plants were harvested by hand pulling for further determination, while insects were observed and captured with the aid of an entomological net. Some of the arthropods were whole preserved in alcohol 95% and transported to the Faculty of Agriculture from USAMV Bucharest laboratories for identify-

cation (Dobrin et al., 2013). Identification guides of Cozari (2008), Leraut (2012) and Rakosy (2013) were used for insect taxonomy.
We have completed our plant species checklists of what was already known in the floristic literature from the monograph of Ilganii de Sus and Partizani villages (Moţoc and Manole, 2015) and also from the work of Doroftei et al. (2011) concerning the vascular wild flora of D.D.B.R.

Figure 1. Natural landscapes of Ilganii de Sus area - habitats for plants and insects, on Sulina Branch

Species name for both plants and insects were arranged for convenience in alphabetical order, rather than phylogenetic, as in similar papers concerning checklists (Abbate, 2005; Ahmed et al., 2017).
Mushrooms, ferns, bryophytes, lichens and algae species were excluded from this report. For plant habit, we used the following abbreviations: H (herb); S (shrub); T (tree). The name of a species is followed by the corresponding family name.
The nomenclature and also the taxonomic position for plant species mostly followed The Plant List (http://www.theplantlist.org/), Invasive Species Compendium (http://www.cabi.org/isc/) and Plants For A Future (http://pfaf.org/) data base.

RESULTS AND DISCUSSIONS

The biological explorations in the Ilganii de Sus village area have produced two checklists of floristic and entomological species, respectively.

I. Plant species checklist

For the studied area, the following plants represent a collection of species recorded before in the specialist literature and/or identified by us in September 2017 and also species recorded only in the specialist literature but not encountered in the present short survey (*):

1. *Acorus calamus* L. (sweet flag), H, Araceae*;
2. *Abutilon theophrasti* Medik. (velvetleaf), H, Malvaceae;
3. *Aldrovanda vesiculosa* L. (waterwheel), H, Droseraceae*;
4. *Alisma plantago-aquatica* L. (common water-plantain), H, Alismataceae*;
5. *Althaea officinalis* L. (marshmallow), H, Malvaceae;
6. *Amaranthus hybridus* L. (green amaranth), H, Amaranthaceae;
7. *A. powelli* S. Watson (Powell's amaranth), H, Amaranthaceae*;
8. *Ambrosia artemisiifolia* L. (common ragweed), H, Asteraceae;
9. *Amporpha fruticosa* L. (indigo bush), S, Fabaceae;
10. *Anthemis ruthenica* M. Bieb., H, Asteraceae*;
11. *A. tinctoria* L. ssp. *tinctoria* (golden marguerite), H, Asteraceae*;
12. *Apera spica-venti* L. (P. Beauv.) (common windgrass), H, Poaceae;
13. *Artemisia annua* L. (sweet sagewort), H, Asteraceae;
14. *Azolla caroliniana* Willd. (mosquito fern), H, Salviniaceae*;
15. *Bromus arvensis* L. (field brome), H, Poaceae*;
16. *B. sterilis* L. (barren brome), H, Poaceae*;
17. *Butomus umbellatus* L. (flowering rush), H, Butomaceae;
18. *Camelina rumelica* Velen., H, Brassicaceae*;
19. *Carduus nutans* L. (nodding thistle), H, Asteraceae;
20. *Carex* sp. (sedges), H, Cyperaceae;

21. *C.* divisa Huds., H, Cyperaceae*;
22. Cephalaria transylvanica (L.) Roem. & Schult., H, Caprifoliaceae*;
23. Ceratocephala testiculata (Crantz) Roth (bur buttercup), H, Ranunculaceae*;
24. Chenopodium pumilio R.Br., H, Amaranthaceae*;
25. C. strictum Roth, H, Amaranthaceae*;
26. C. urbicum L. (city goosefoot), H, Amaranthaceae;
27. Cichorium intybus L. (chicory), H, Asteraceae;
28. Cicuta virosa L. (cowbane), H, Apiaceae*;
29. Cirsium acaule (L.) A. A. Weber ex Wigg. (dwarf thistle), H, Asteraceae;
30. Consolida orientalis (J. Gay) Schrödinger, H, Ranunculaceae;
31. C. regalis Gray (forking larkspur), H, Ranunculaceae;
32. Cuscuta campestris Yunck. (field dodder), H, Convolvulaceae;
33. Cynodon dactilon (L.) Pers. (bermuda grass), H, Poaceae;
34. Cyperus glomeratus L., H, Cyperaceae*;
35. Datura stramonium L. (jimsonweed), H, Solanaceae;
36. Dipsacus fullonum L. (common teasel), H, Dipsacaceae;
37. Eleagnus angustifolia (Russian olive), T, Elaegnaceae;
38. Elodea canadensis Michx. (pondweed), H, Hydrocharitaceae*;
39. E. nuttallii (Planch.) H.St.John (western waterweed), H, Hydrocharitaceae*;
40. Equisetum palustre L. (marsh horsetail), H, Equisetaceae*;
41. Erigeron annuus (L.) Pers. (annual fleabane) syn. Stenactis annua (L.) Ness., H, Asteraceae;
42. Euphorbia sp. (spurge), H, Euphorbiaceae;
43. Euphorbia salicifolia Host, H, Euphorbiaceae*;
44. Fraxinus sp. (ash), T, Oleaceae;
45. Galega officinalis L. (goat's rue), H, Fabaceae;
46. Galium palustre L. (marsh-bedstraw), H, Rubiaceae*;
47. Glycyrrhiza glabra L. (liquorice), H, Fabaceae;
48. Helianthus annuus L. (sunflower), H, Asteraceae;
49. Hydrocharis morsus-ranae L. (frogbit), H, Hydrocharitaceae*;
50. Inula britannica L. (meadow fleabane), H, Asteraceae;
51. Iris variegata L., H, Iridaceae*;
52. Lamium purpureum L. (purple dead-nettle), H, Lamiaceae*;
53. Leonorus marrubiastrum L., H, Lamiaceae*;
54. Lemna sp. (duckweed), H, Araceae;
55. Limonium latifolium (Sm.) Kuntze (sea lavander), H, Plumbaginaceae*;
56. Linaria vulgaris Mill. (yellow toadflax), H, Plantaginaceae;
57. Lithospermum purpurocaeruleum L. (purple gromwell), H, Boraginaceae;
58. Lotus corniculatus L. (bird's-foot trefoil), H, Fabaceae;
59. Lycopsis arvensis L. syn. Anchusa arvensis (L.) M. Bieb., H, Boraginaceae*;
60. Lythrum salicaria L. (purple loosestrife), H, Lythraceaceae;
61. Malus sylvestris L. (crab apple), T, Rosaceae;
62. Matricaria perforata L. (false chamomile), H, Asteraceae;
63. Medicago lupulina L. (black medick), H, Fabaceae;
64. Melilotus albus Medik. (white melilot), H, Fabaceae;
65. Mentha aquatica L. (water mint), H, Lamiaceae;
66. M. longifolia L. (Huds.) (horsemint), H, Lamiaceae;
67. M. pulegium L. (pennyroyal), H, Lamiaceae;
68. Myriophyllum sp. (watermilfoil), H, Haloragaceae*;
69. Morus alba L. (mulberry), T, Moraceae;
70. Nigella arvensis L. (wild fennel), H, Ranunculaceae*;
71. Nuphar lutea (L.) Sm. (yellow water-lily), H, Nymphaeaceae*;
72. Nymphaea alba L. (European white water lily), H, Nymphaeaceae*;
73. Nymphoides peltata (Gmelin.) Kuntze. (water fringe), H, Menyanthaceae;
74. Oenanthe aquatica (L.) Poir. (water dropwort), H, Apiaceae*;
75. Ononis spinosa L. (spiny restharrow), H, Fabaceae;
76. Orchis laxiflora Lam., H, Orchidaceae*;

77. Origanum vulgare L., H, Lamiaceae*;
78. Orobanche ramosa L. (branched broomrape), H, Orobanchaceae*;
79. Papaver hybridum L., H, Papaveraceae*;
80. P. rhoeas L. (field poppy), H, Papaveraceae*;
81. Petunia parviflora Juss., H, Solanaceae*;
82. Phragmites australis (common reed), H, Poaceae;
83. Plantago major L. (common plantain), H, Plantaginaceae;
84. Poa trivialis L. (rough bluegrass), H, Poaceae*;
85. Polycnemum arvense L., H, Amaranthaceae*;
86. Polygonum hydropiper L. (smartweed), H, Polygonaceae;
87. P. mite Schrank, H, Polygonaceae*;
88. Potamogeton crispus (pondweed), H, Potamogetonaceae*;
89. P. pectinatus L. (fennel-leaved pondweed), H, Potamogetonaceae*;
90. P. perfoliatus L. (claspingleaf pondweed), H, Potamogetonaceae*;
91. Populus alba L. (white poplar), T, Salicaceae;
92. Pyrus pyraster L. (wild pear), T, Rosaceae;
93. Potentilla reptans L. (cinquefoil), H, Rosaceae*;
94. Raphanus raphanistrum L. (wild radish), H, Brassicaceae*;
95. Ranunculus ficaria L. (lesser celandine), H, Ranunculaceae*;
96. R. oxyspermus Willd., H, Ranunculaceae*;
97. Robinia pseudoacaia L. (black locust), T, Fabaceae;
98. Rorripa palustris L. (Besser.) (common yellow-cress), H, Brassicaceae;
99. Rubus caesius L. (dewberry), S, Rosaceae;
100. Rumex hydrolapathum Huds. (water dock), H, Polygonaceae;
101. Sagittaria sagittifolia L. (arrowhead), H, Alismataceae*;
102. Salix alba L. (white willow), T, Salicaceae;
103. S. aurita L. (eared willow), T, Salicaceae*;
104. S. cinerea (grey willow), S, Salicaceae*;
105. S. fragilis (crack willow), T, Salicaceae*;
106. S. petandra (bay willow), T, Salicaceae*;
107. S. purpurea L. (purple willow), S, Salicaceae*;
108. S. rubra Huds., S, Salicaceae*;
109. Salvinia natans (L.) All. (floating fern), H, Salviniaceae;
110. Setaria viridis (L.) P.Beauv. (green foxtail), H, Poaceae;
111. Sinapis arvensis L. (wild mustard), H, Brassicaceae*;
112. Sonchus oleraceus L., H, Asteraceae;
113. Stachys tenuifolia Willd. (smooth hedgenettle), H, Lamiaceae;
114. Solanum dulcamara L. (bittersweet), H, Solanaceae*;
115. Sparganium ramosum Huds., H, Typhaceae*;
116. Stellaria sp., H, Caryophyllaceae;
117. S. aquatica L. (Scop.) (water chickweed), H, Caryophyllaceae*;
118. Symphytum officinale L. (comfrey), H, Boraginaceae*;
119. Tamarix gallica L. (French tamarisk), S, Tamaricaceae;
120. Tanacetum vulgare L. (tansy), H, Asteraceae;
121. Thalictrum lucidum L., H, Ranunculaceae*;
122. Trachomitum venetum L. (Woodson), H, Apocynaceae*;
123. Trapana natans L. (water caltrop), H, Lythraceae;
124. Trifolium echinatum M. Bieb. (hedgehog clover), H, Fabaceae*;
125. T. pretense L. (red clover), H, Fabaceae;
126. T. repens L. (white clover), H, Fabaceae;
127. Typha angustifolia L. (narrow-leaved cat-tail), H, Typhaceae;
128. Utricularia vulgaris L. (common bladderwort), H, Lentibulariaceae*;
129. Valerianella lasiocarpa (Steven) Betcke, H, Caprifoliaceae*;
130. Vallisneria spiralis L. (eel grass), H, Hydrocharitaceae*;
131. Verbascum chaixii Vill. ssp. orientale Hayek, H, Scrophulariaceae*;
132. V. phlomoides L. (orange mullein), H, Scrophulariaceae;

133. Verbena officinalis L (vervain), H, Verbenaceae;
134. Xanthium spinosum L. (bathurst burr), H, Asteraceae;
135. X. strumarium L. (common cocklebur), H, Asteraceae.

Among all 46 plant families, Asteraceae is the most dominant with 15 species (11.11%), followed by Fabaceae with 11 species (8.15%), Salicaceae with eight species (5.92%), Lamiaceae Poaceae and Ranunculaceae with seven species each (5.18%), Amaranthaceae with six species (4.44%), Brassicaceae, Hydrocharitaceae and Rosaceae with four species each (2.96%), Boraginaceae, Cyperaceae, Polygonaceae, Potamogetonaceae and Solanaceae with three species each (2.22%). Alismataceae, Apiaceae, Araceae, Caprifoliaceae, Caryophyllaceae, Euphorbiaceae, Lythraceae, Malvaceae, Nymphaceae, Papaveraceae, Plantaginaceae, Salviniaceae, Scrophulariaceae and Typhaceae plant families had two species each (1.48%). The recorded plant families including a single species (0.74%) were: Apocynaceae, Convolvulaceae, Dipsacaceae, Droseraceae, Elaegnaceae, Haloragaceae, Iridaceae, Lentibulariaceae, Moraceae, Menyanthaceae, Orchidaceae, Oleaceae, Orobanchaceae, Plumbaginaceae, Rubiaceae, Tamaricaceae and Verbenaceae. As for the plant habit, herbaceous species represent 87.4% of the floristic composition in the study area, followed by trees (8.15%) and shrubs (4.44%).
Species noted herein as „*” represent 50.37% from the total of 135 listed records. Most of these plants have not been identified in the field for the simple reason that we did not intend to study the aquatic plants for this stage of the report. On the other hand, it should be noted that a significant part of the herbs labeled with „*” should be regarded with caution concerning the floristic species attributed to Ilganii de Sus, since in the available Romanian literature there are plant species generally cited for the Danube Delta or for Ilganii, not necessary only for the present area of interest. As a result, new field trips over the course of a whole year could bring the light to the exact elucidation of the Ilganii de Sus flora’s composition.

II. Insect species checklist

In September 2017, we identified the following insect species in the collecting sites of Ilganii de Sus:

1. *Aelia acuminata* L. (Bishop’s mitre shieldbug), Heteroptera: Pentatomidae;
2. *Apion apricans* Herbst (Coleoptera: Brentidae);
3. *Bacillus rossius* Rossi (stick insect), Phasmatodea: Bacillidae;
4. *Calliptamus italicus* L. (Italian locust), Orthoptera: Acrididae;
5. *Cassida nebulosa* L. (tortoise beetle), Coleoptera: Chrysomelidae;
6. *Cantharis rufa* L., Coleoptera: Cantharidae;
7. *Catocala nupta* L. (red underwing), Lepidoptera: Erebidae;
8. *Ceresa bubalus* Fabricius (buffalo tree hopper), Hemiptera: Membracidae;
9. *Cicadella viridis* L. (green leafhopper), Hemiptera: Cicadellidae;
10. *Chrysolina polita* L. (knotgrass leaf beetle), Coleoptera: Chrysomelidae;
11. *Chrysolina virgata* Motschulsky (leaf beetle), Coleoptera: Chrysomelidae;
12. *Chrysopa* sp. (Neuroptera: Chrysopidae);
13. *Subcoccinella vigintiquatuorpunctata* L. (24-spoted ladybird), Coleoptera: Coccinellidae;
14. *Coreus marginatus* L. (dock bug), Hemiptera: Coreidae;
15. *Decticus verrucivorus* L. (wart-biter), Orthoptera: Tettigonidae;
16. *Dociostaurus maroccanus* Thunberg (Moroccan locust), Orthoptera: Acrididae;
17. *Dolycoris baccarum* L. (sloe bug), Hemiptera: Pentatomidae;
18. *Graphosoma lineatum* L. (Hemiptera: Pentatomidae);
19. *Hamearis lucina* L. (Duke of Burgundy), Lepidoptera: Riodinidae;
20. *Lasius niger* L. (black garden ant), Hymenoptera: Formcidae;
21. *Meligethes aeneus* Fabricius (rape pollen beetle), Coleoptera: Nitudulidae;
22. *Musca domestica* L. (housefly), Diptera: Muscidae;
23. *Orthetrum cancellatum* L. (black-tailed skimmer), Odonata: Libellulidae;
24. *Pieris rapae* L. (small cabbage white), Lepidoptera: Pieridae;

25. *Polyommatus coridon* Poda (chalkhill blue), Lepidoptera: Lycaenidae;
26. *Polyommatus icarus* Rottemburg (common blue), Lepidoptera: Lycaenidae;
27. *Pyrrhocoris apterus* L. (firebug), Hemiptera: Pyrrhocoridae;
28. *Trichodes apiarius* L., Coleoptera: Cleridae.

Among all 28 insect species listed above, Coleoptera is the most dominant order, with eight species (28.57%), followed by Hemiptera with six species (21.42%), Lepidoptera with five species (17.85%) and Orthoptera with three species (10.71%).

The insect orders with a single identified species (3.57%) were: Diptera, Heteroptera, Hymenoptera, Neuroptera, Odonata and Phasmatodea.

Aelia acuminata, *Coreus marginatus* and *Graphosoma lineatum* were also recorded in Ilganii de Jos area (Dobrin et al., 2013).

CONCLUSIONS

A total of 135 plant species and 28 insect species were recorded for the study area.

The leading taxa in the collected biological samples were Asteraceae for floristic composition and Coleoptera for insect biodiversity, respectively.

Although we can not conclude that the two checklists of species present an exhaustive picture of the biodiversity of a well-defined region, we believe that this survey brings an important contribution to the knowledge of plant and arthropod species adjacent to Ilganii de Sus - a protected area from Danube Delta Biosphere Reserve.

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