Valeriy Sergeevich Tshovrebov et al /J. Pharm. Sci. & Res. Vol. 9(11), 2017, 2212-2217

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

The Impact of the Anthropogenic Factor on the Abundance and Seasonal Dynamics of Micromycetes in Chernozems of the Central Ciscaucasia

Valeriy Sergeevich Tshovrebov, Vera Ivanovna Faizova, Dmitry Vasilyevich Kalugin, Anastasia Mikhailovna Nikiforova
Stavropol State Agrarian University, 355017, Russia, Stavropol, Zootechnichesky Pereulok, 12

Ludmila Mikhailovna Onishchenko
Kuban State Agrarian University named after I.T. Trubilin, 350044, Russia, Krasnodar, Kalinina St., 13

Abstract.

The article presents the results of multi-year research of the state of microscopic fungi in paired plots of virgin and arable chernozems of the Central Ciscaucasia. The research was performed in the seasonal dynamics at key sites of the southern, ordinary and leached chernozems under winter wheat. For the first time, the article identifies experimentally, analyzes, summarizes and grounds theoretically the changes in the microbiological indicators of different subtypes of chernozems in their long-term use in agricultural production in the system of arable land for the zone of the Central Ciscaucasia. The general direction of development of degradation processes of arable land soils was established.

It was stated that there is a substantial transformation of the micromycete composition of arable chernozems compared to the virgin land, which is expressed in their abundance growth and the emergence of significant dynamics of seasonal indicators.

Keywords: chernozems, virgin land, arable land, micromycetes, winter wheat.

INTRODUCTION

The anthropogenic impact is a powerful lever of regulation of the fertility and microbial status of soils. The issues of the impact of an agricultural factor and its role in soil fertility began to be discussed in the early 20th century, when Kostychev (1926) [1] argued that from the agronomic point of view, the study of soils without their microbiological characteristics cannot be called complete.

Currently, there is no consensus in the literature about the degree of anthropogenic impact on the soil with the aim of obtaining high yields of agricultural crops [2, 3]. Learning different methods of influence on the soil cover, a growing number of researchers pay attention to the living matter of soils [4-5]. In their view, the problems of preservation and reproduction of the fertility of chernozems must be solved through the knowledge of the patterns of development and direction of the processes conditioned by the complex of soil microorganisms. The living substance of the soil is crucial in the direction of a soil-forming process. In ecological systems, including soil, a biological balance is established, which is disturbed as a result of the anthropogenic impact [6]. An agricultural use of chernozems leads to the changes in the composition of a living matter of soils, which are caused by the use of various agronomic practices, application of fertilizers, influence of vegetation, etc. [7].

There is a whole community of different herbs on the virgin land, which ensures the turnover of the cycles of sprouting, growing, flowering and withering away during the whole vegetation period. This contributes to a rich microbial diversity of soils [8]. There is a monoculture on the arable land. All the microbial community is controlled not only by the phase of its development, but also the quantity and quality of repetitive root excretions. This leads to the transformation of microbial communities and soil fatigue. The qualitative and quantitative indicators of such changes affect the productivity of agrocenoses and profitability of products.

The aim of our research was to identify the abundance dynamics of microscopic fungi on virgin and arable chernozems of the Central Ciscaucasia.

OBJECTS AND METHODS OF RESEARCH

To conduct microbiological research by the "keys" method, the paired sections of virgin and arable lands in the different subtypes of chernozems of the Central Ciscaucasia were selected: southern (key 1), ordinary carbonate (key 2), ordinary usual (key 3), leached (key 4), alkaline (key 5) and alkaline-compact (key 6). The southern chernozems, the ordinary and the leached ones were formed on loess loams, the alkaline and the alkaline-compact chernozems – on eluvium of Maykop clays.

The observations were carried out from 2004 to 2012. Winter wheat was sown on the arable land. The virgin herbage on all the studied chernozems was represented mainly by motley grass-grasses associations.

On the virgin areas, the research was conducted at the same time as on the arable ones. The selection of soil samples for analysis from the rhizosphere zone was performed in the seasonal dynamics by the main vegetation phases of winter wheat: autumn and spring tillering, booting, flowering, milky ripeness and the post-harvest period.

The isolation and counting of microscopic fungi were carried out on the Czapek-Dox medium acidified with the citric acid and with the addition of 100 µg/ml streptomycin to suppress the bacterial growth. For sowing, the dilution of 10^{-3} was used.

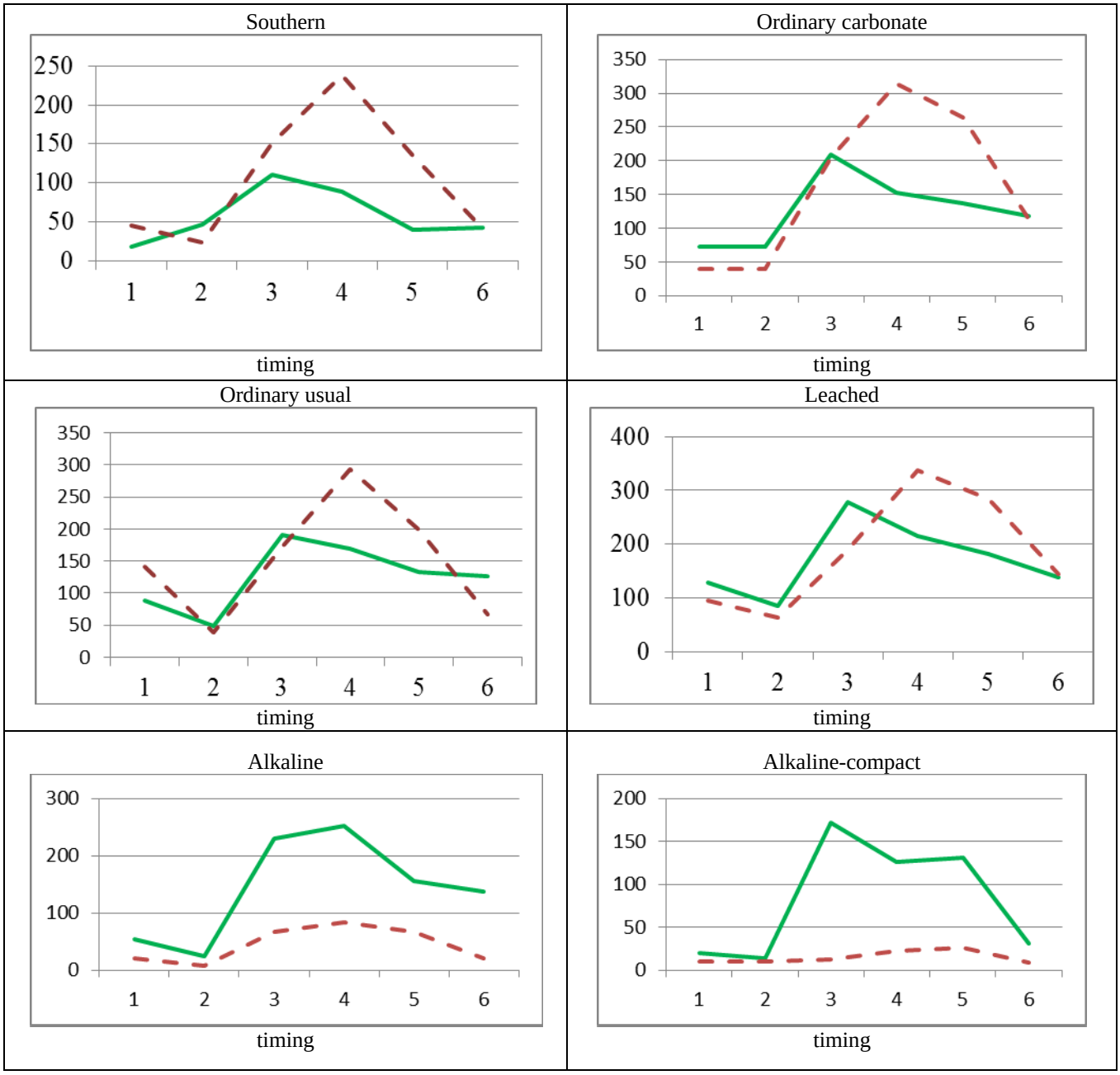
The climate of the research area is characterized by hot summer (3400-3600 °C) and moderately mild winter. The amount of precipitation is: key 1 – 472 mm, key 2 – 575 mm, key 3 – 551 mm, key 4 – 526 mm, keys 5

and 6 – 491 mm. During the research, 2007 and 2010 were the driest years. Aridity was manifested in the time of earing and flowering of winter wheat. At that, 2004 was wet, when the amount of precipitation in certain periods exceeded the long-term average annual values by 200-345%. The remaining years by the falling precipitation were close to the long-term average annual indicators.

Results And Discussion

The analysis of the seasonal dynamics of the micromycete abundance on the average by years of research (Figure 1) revealed that on the virgin land of the southern chernozem the minimum values fell to the autumn period of research and made up 18.9 thousand colony-forming units (CFU). The maximum values occurred in the periods corresponding to the booting phase of winter wheat. The difference was 2.3 times.

The arable land had the same pattern. The lowest number of microorganisms was in the spring tillering phase and amounted to 23.7 thousand CFU/1 g of soil; it increased by 10.1 times in the flowering phase. Thus, the difference between the natural land and arable land in that period was 149 thousand CFU/1 g of soil.



Note: * The selection was made simultaneously on the virgin and arable lands

Figure 1 – The seasonal dynamics of the micromycete abundance by the vegetation phases on the average for the years of research, thousand CFU/1 g: 1. Autumn tillering; 2 Spring tillering; 4 Flowering; 3 Booting; 5 Milky ripeness; 6 Post-harvest period

On the carbonate chernozem, the minimum number of micromycetes on the virgin land fell to the autumn and early spring periods with the fluctuations within 71.9-73.3 thousand CFU/1 g of soil. The maximum values were recorded in the period corresponding to the booting phase of winter wheat. The difference was 2.9 times.

On the arable land, the smallest number of the studied microorganisms fell to the spring tillering phase and amounted to 38.9 thousand CFU/1 g of soil. To the flowering phase of winter wheat, the studied figure increased by 8.0 times and exceeded the similar indicator on the virgin land by 162.7 thousand CFU/1 g of soil.

On the ordinary and leached chernozems, the same pattern was observed. It should be noted that there was an overall increase in the number of the studied group of microorganisms in these chernozem subtypes in comparison with the southern chernozem. It was most significantly expressed on the leached chernozem, and less essentially – on the carbonate one.

On the alkaline and alkaline-compact chernozems, a different picture arose. The abundance of microscopic fungi on the virgin land was greater than their number on the arable land in all periods of research.

The smallest number of fungi on the virgin land of the alkaline chernozem fell also to the initial period of the growth and development of plants and was 25.1 thousand CFU/1 g of soil. In the following research periods, the number of micromycetes increased significantly and exceeded the minimum value by 10.1 times.

On the arable land in the seasonal dynamics, the difference between the extreme values was also 10.2 times, but the minimum and maximum values were lower than the virgin ones by 16.9 and 168.6 thousand CFU/1 g of soil, respectively.

A similar pattern was observed on the alkaline-compact chernozem. At the smallest amount of fungi on the virgin land in early spring (13.6 thousand CFU/1 g of soil), the difference between the minimum and maximum values was 17.7 times. On the arable land, in these terms of research any significant difference in the studied indicators was not identified. Thus, in the early spring tillering phase of winter wheat the number of micromycetes amounted to 9.7 thousand CFU/1 g, and in the flowering phase increased by 13.2 thousand CFU/1 g. So, the difference was only 2.4 times.

It is well known that microscopic fungi are strict aerobes. Soils formed on eluvium of marine genesis rocks have a number of adverse physical properties [8-10]. The studied chernozems were formed on eluvium of ancient Maykop clays. On the arable land compared to the virgin soil, they are mostly structureless, overconsolidated and have low levels of porosity, which guarantee their weak aeration and development of anaerobic processes. This adversely affects the development of microorganisms of this physiological group.

When conducting the correlation and regression analysis of the data obtained by the Tukey method (Figure 2), it was revealed that on the southern chernozem on the virgin land in the previously marked seasonal dynamics of indicators, the values of the scale of fifty percent of the sample were negligible. This was particularly evident in the periods corresponding to autumn and spring tillering of winter wheat, when the studied indicators were in the range of 18.9-110.1 thousand CFU/1 g of soil. During the periods of active growth of virgin vegetation in late spring and summer, the values of fifty percent of the sample increased, and the extreme values increased with them.

On the arable land, with the increase in the abundance of microorganisms, the values of fifty percent of the sample increased on the average by 2.0-2.5 times. This was especially noticeable in the phases of flowering and milky ripeness.

This indicates more tension of the soil-forming process in the agrocenosis compared to the virgin system.

There was a similar picture on the ordinary chernozems, both on the carbonate and usual ones.

On the leached chernozem, the absence of any significant difference of the studied indicators between the virgin soil and the arable land was noted. There is a completely different situation on the chernozems formed on eluvium of Maykop clays. The values of fifty percent of the sample of the box-and-whisker plot, invented by J. Tukey, were not significant and ranged from 10 to 30 thousand CFU/1g. There was also a slight difference between the emissions from fifty percent of the sample. In some periods of this research, the extreme values, and especially their lower indicators, were not marked. However, the emergence of emission can be noted which speaks in general about the instability in the system; it apparently happens due to the significant variation of the moisture indices of these soils, and unstable and not considerable portion of the root and plant litter. Thus, through the example of these soils, micromycetes show their great tolerance when adapting to different soil conditions.

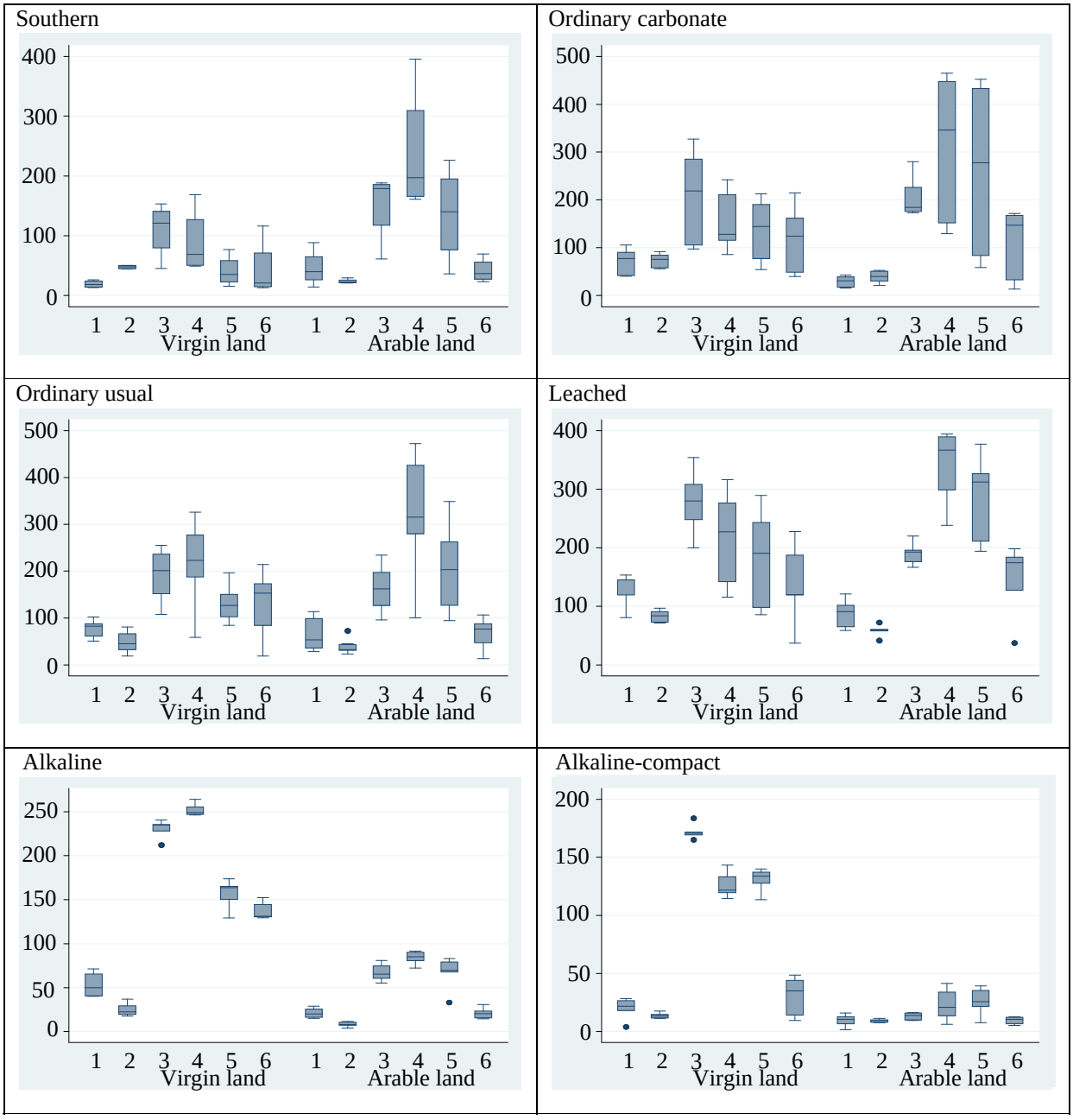
If we compare the average number of micromycetes during the vegetation period by the years (Figure 3) on the southern chernozem, we can observe the increase in the studied indicator on the arable land compared to the virgin land by 1.8-2.5 times. The highest values corresponded to the wet 2006, and the lowest ones – the arid 2007.

There was such a trend on the carbonate chernozem. On the ordinary chernozem, the number of fungi on the virgin land was slightly higher compared to the arable land in 2004, 2007, 2009 and 2012.

On the leached chernozem in 2004 and 2011, the number of micromycetes was higher on the arable land, although not essentially. In 2005, 2007 and 2009, the content of fungi on the arable land exceeded the same indicator on the virgin land. In our opinion, this can be explained by the fact that the biomass of cultivated vegetation, which indirectly through the root excretions stimulates the development of fungal microflora, is larger on the arable land.

In key areas of alkaline and alkaline-compact chernozems, the picture changes dramatically. On alkaline soils, the number of micromycetes on the virgin land was 2-4 times higher than on the arable land for all the years of research. On the alkaline-compact chernozem, the

difference between the virgin soil and the arable land was even higher and amounted to 7-8 times. This once again confirms the negative impact of the adverse physical properties of soils formed on rocks of marine genesis on the growth and development of microscopic fungi.



Note:* The selection was made simultaneously on the virgin and arable lands

Figure 2 – The variation and statistical indicators of the content of micromycetes on the virgin and arable lands in general for all the years of research, thousand CFU/1 g: 1. Autumn tillering; 2 Spring tillering; 4 Flowering; 3 Booting; 5 Milky ripeness; 6 Post-harvest period

Figure 3 – The average number of micromycetes during the vegetation period by the years of research in different subtypes of chernozems, thousand CFU/1 g

CONCLUSION

Thus, the analysis of the abundance of micromycetes identified a natural increase in their number for all the years of research on the arable land compared to the virgin land on the chernozems: southern – by 1.6-2.2 times, ordinary carbonate – by 1.1-1.6 times, ordinary usual – by 1.1-1.2 times, leached – by 1.2-1.4 times. On the alkaline and alkaline-compact chernozems, vice versa, the number of fungi on the virgin land exceeded the same indicator on the arable land on the average by 2.1 and 5.4 times, respectively.

On the virgin land, compared to the arable land, the seasonal dynamics of the studied value, conditioned, in our opinion, by a rich variety of virgin herbage, is poorly expressed. On the arable land there are considerable seasonal fluctuations in the abundance of microscopic fungi reaching 8-10 times.

REFERENCES:

1. Kostychev, S.P. (1926). *Pochvovedenie* [Soil Science]. Moscow: Publishing House of AN SSSR. (p. 390).
2. Mishustin, E.N. (1975). *Assotsiatsii pochvennykh mikroorganizmov* [Associations of Soil Microorganisms]. Moscow: Nauka. (p. 184).
3. Esaulko, A.N., Sigida, M.S., Salenko, E.A., Korostylev, S.A., & Golosnoy, E.V. (2015). Agrochemical Principles of Targetting Winter Wheat Yield on Leached Chernozem of the Stavropol Elevation. *Biosciences, Biotechnology Research. Asia, 12*(1), 301-309.
4. Mirchink, T.G. (1984). Pochvennye griby kak komponent biogeotsenoza [Soil Fungi as a Component of Biogeocenosis]. In *Pochvennye mikroorganizmy kak komponenty biogeotsenoza* [Soil Microorganisms as Components of Biogeocenosis] (pp. 114-131). Moscow: Nauka.
5. Marfenina, O.E. (1999). *Antropogennye izmeneniya kompleksov mikroskopicheskikh gribov v pochvakh: avtoref. dis…. doktora biologicheskikh nauk* [The Anthropogenic Changes in Complexes of Microscopic Fungi in Soils (Doctoral Thesis Abstract)]. Moscow: Moscow State University. (p. 48).
6. Nickerson, K., Atkin, A.L. & Hornby, J.M. (2006). Quorum Sensing in Dimorphic Fungi: Farnesol and Beyond. *Applied Environmental Microbiology, 72*(6), 3805-3813.
7. Tskhovrebov, V.S., Faizova, V.I., Marin, A.N., Novikov, A.A. & Nikiforova, A.M. (2016). Changing In Ammonifiers of Virgin Land and Black-Earth Ploughland to Central Ciscaucasia. *Research Journal of Pharmaceutical, Biological and Chemical Sciences, 7*(4), 2174.
8. Ageev, V.V., Lobankova, O.Yu., Grechishkina, Yu.I., Lysenko, I.O., Podkolzin, O.A., & Fursova, A.Yu. (2016). Kalii v sovremennom zemledelii. Problemy i ikh resheniya [Potassium in Modern Agriculture. Problems and Solutions]. *Vestnik APK Stavropolya, 2*(22), 115-121.
9. Grechishkina, Yu.I., Gorbatko, L.S., Lobankova, O.Yu., & Belovolova, A.A. (2015). Vliyanie sovmestnogo primeneniya makro- i mikroudobrenii na azotnyi rezhim chernozemnykh pochv Tsentralnogo Predkavkazya [The Influence of Joint Application of Macro- and Micronutrients on Nitric Regime of Chernozem Soils of the Central Ciscaucasia]. *Harvard Journal of Fundamental and Applied Studies, 1*(7), 2007-2014.