Food crop responses to various factors in Romania

ROTARU ANDA, MATEI MONICA*, COMAN VALENTINA, LASLO LUCIAN, VOICU MADALINA, LUPEI THEODOR, BARA NORBERT, BOBOC MADALINA, DEÁK GYÖRGY
Climate Change and Sustainable Development Department,
National Institute for Research and Development in Environmental Protection,
294 Splaiul Independenței Blv, District 6, Zip code 060031, Bucharest,
ROMANIA
anda_irena@yahoo.com http://www.incdpm.ro/
*coresponding author: monicamatei06@gmail.com

Abstract: Being an important source of vitamins from almost all known types, through their content in mineral salts and through their carbohydrate intake, vegetables are a significant component of food strategies. In this paper are analyzed various factors that can affect the ability to adapt to different conditions, including the climatic ones, of certain vegetable crops from Romania. Therefore, soil samples were taken from different crops of vegetables (onion, beans and pepper) and from the water used for irrigation from the study area, located at the Vegetable Research and Development Station, Buzau, located in the south-east of Romania, on the eastern part of the Curvature Carpathians. The content of nutrients was analyzed, the amount of humus, soil pH and other elements that can influence the development of plants, according to relevant published literature. At the same time, the average air and soil temperature data, from 1961-2013, from the Buzau weather station, were analyzed in order to detect the growth trends of these parameters. Trends of increasing air and soil temperature were detected for the analyzed time span, with higher increases being detected in the decade 2001-2010.

Key-Words: Agriculture, Vegetables, Soil, Climate change, Air temperature, Soil temperature.

1 Introduction

Romania's climate is influenced especially by its location (crossed by the parallel of 45°N), as well as by its topographic particularities. These particularities give the climate a temperate continental character. Although the extension of the territory of the country on latitude (5°) is smaller than that on the longitude (10°), there are greater differences between the south and north of the country regarding the temperature, than between west and east. If the annual average temperature in the south of the country rises to about 11° C, in the north of the country, due to differences of altitudes, the values are lowered by about 3° C [5]. Due to the geographical location, the main effects of the current or future climate change in Romania are represented by drought phenomena [12].

According to studies conducted by the Romanian National Meteorological Administration, the southeastern part of Romania is probably to be the most affected part of the country to the effects of climate change, the most common phenomenon being drought. Especially those areas that currently have large water resources and are exposed to climate change, must develop useful practices to deal with water shortages [20].

The study area is located at the Vegetable Research and Development Station Buzău, in Buzau County (Fig. 1.), located in the south-east of Romania, on the eastern part of the Curvature Carpathians.

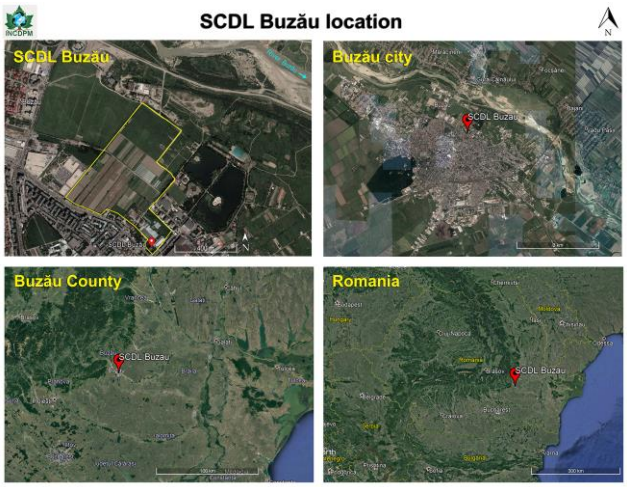

Fig. 1 Location of the study area in Romania

The area is characterized by a temperate continental climate, which varies from north to south due to the altitude, the general orientation of the relief and its local configuration (mountains,

hills and fields, meadows), which generates several microclimatic zones [17],[33]. It also presents large annual thermal amplitudes and an unequal distribution of precipitation both temporally and spatially [16].

According to a study conducted in the early 1980s, the predominant soil types in Romania are alluvial soils 49.3% followed by molisols 46% and halomorphic soils by 4.2% [30].

Romania has an important agricultural resources from which agricultural area occupies 13.3 million ha (representing 55.8% of Romania's territory), most of which is arable land (8.3 million ha) [1].

Within the agricultural production in Romania, vegetable farming represents a field with a high degree of intensity and a high weight, with major implications in the national economy and especially in the population nutrition [7].

Vegetable farming is a part of agriculture, which has been influenced in recent years by the negative effects of climate change affecting the quantity and quality of vegetables. The most aggressive phenomena of climate change are represented by temperature increases that affect agricultural crops, but also the water scarcity in soil that has become overdue from year to year since 1984 and causes the systematic decrease of agricultural yield [14].

Current climate conditions lead to changes in temperature and precipitation affecting vegetable crops by changing the vegetation period, which leads to changes in some ecosystem areas. The main problem that Romanian farmers faced, in the context of climate change, is that most of the time they cannot set up their crops in proper time [14].

Climate change-induced high temperatures and droughts, can lead to development of tolerant cultivars in major food crops, ecological control of weeds and pests, the improvement of vegetable cultivation technologies and the modernization of plant shading systems. [8].

Climate and agriculture influence each other, considering that agriculture release greenhouse gases into the atmosphere. On the other hand, agriculture can also contribute to climate change mitigation by sequestering carbon dioxide. Moreover, changes in air temperature, together with rising frequency and intensity of extreme weather events, such as heat waves, could have significant impacts on crop yields.. Moreover, the ability of rural areas to provide adequate food, supporting the economic development and providing a safe living environment for rural communities, depends directly on favorable climatic conditions [14].

2 Problem Formulation

Environmental changes including climate change, land degradation, water scarcity and loss of biodiversity - which are expected to become deeper in the 21st century - pose significant challenges for global agriculture, food security and nutrition [24].

According to the *National Strategy on climate change and economic growth based on low carbon emissions*, medium and long term, climate change will increasingly affect Romania and its agricultural sector. Same as the projections for Europe, Romanian climate follows the same trend, with an expected increase of the annual average temperature, between 0.5°C and 1.5°C by 2029 or between 2.0°C and 5.0°C until 2099, according to the worst case scenario.

According to the results of the *study "Effect of environmental changes on vegetable and vegetable yields and nutritional quality"*, conducted by Pauline FD Scheelbeek in 2018, in the absence of adaptation measures and strategies, vegetable crops will be affected in such a way that vegetable yield will be diminished by about a third, in the second half of the 21st century. Since vegetable farming is an important source of food for the population of Romania [28], in this article was analyzed the resilience to climate change effects of various food crops (onions, beans and peppers), by physical and chemical analysis of the soil samples, the water used for irrigation and the climate data.

Onion, pepper and bean crops are herbaceous plants, matching Romania specific climate as annual, biennial or triennial plants - like onion crops [6],[11],[28].

The areas with high favorability for these type of crops are mainly located in the south and south-easters part of the country, respectively in the plains and hilly relief units [11],[23],[28].

Climate and soil are particularly important elements in pepper and beans cultivation and largely dictate the production. The biological threshold is considered at + 15°C. Temperatures below 10°C and 15°C for pepper cultivation are unfavorable for the development of vegetative organs, and vegetative growth stops [4]. Temperatures above 30°C are unfavorable for flowering and fertilizing bean plants, and temperatures above 35°C accompanied by atmospheric drought favor flower abortion in pepper crops, because pollen loses its vitality, which leads to decreased production [4].

Onion crop, compared to the other two crops, does not necessarily develop in hot weather

conditions. It is considered a plant resistant to cold, moreover, mature plants with bulbs withstand up to -7°C. The seed grows to + 3°C, the optimum vegetation temperature is 18°C - 20°C. Higher temperatures ranging from 20°C to 30°C, favor the faster growth of the bulbs but have a lower average weight, as a result of slowing down or stopping the synthesis processes [4].

The three types of crops have different sowing times. In onion crops, because the seed grows to + 3°C, the planting begins after a higher temperature has been recorded for a certain time span. This record corresponds to the second half of March, when the land is plowed and can begin with the aggregate for sowing [4].

The pepper crop through seedlings is possible only after the soil temperature reaches 14°C - 15°C, which in the climatic conditions of our country concur with the first decade of May in the warmer areas, and the second decade or even the third in the cold ones [26]. Regarding bean crops, the optimal time for sowing is when in soil, at the depth of sowing, temperatures reach 8°C - 10°C and the weather is warming up. The effects of delay in sowing are extremely harmful: the soil loses water and dries up, so that germination and plant emergence are delayed and uneven; flowering and fertilization is delayed and prolonged during the dry and hot summer, which amplifies the abortion and sterility processes; production is considerably reduced. The early sowing of beans is also harmful: in wet and cold soil, the plant emergence is delayed, favoring the clogging and rotting of the beans [25].

Soil has an important role in agriculture, being a complex heterogeneous environment (aqueous, gaseous and solid components) containing mineral constituents, organic matter and constituting a support for the living organisms [27]. The genetic type of soil has its contribution by its main property - fertility, to which is added the capacity of drainage and water retention [32].

For onion crops alluviums and soils with a sandy clay texture with a pH between 6 and 7 are indicated [4] and N.S. Avdonin mentions a pH of 6,4-7,9 ; humus content must be rich (> 7%) [4],[13].

For pepper crops, the recommended types of soil are the alluvial soils, the smooth chernozems, as well as the brown-reddish forest soils with a clay-clay texture [4]. The content of fertilizing elements must be high (and humus content rich) and rich in humus content (over 7%) [4],[11]. The pH value should be between 6 and 6.6, Apahidean mentioning a pH of 6-7, and Berke a pH of 5,5 - 6,8 [2],[3],[4].

Bean culture does not requires a certain soil texture, but crust-forming soils should be avoided, and the pH value should be between 6,5 and 7,5 and Bruma S. mentions a pH of 6,1 - 7,4 [4],[28]. The best results are obtained on the chernozems, reddish-brown and alluvial soil, but can also be cultivated on the lightly textured brown soils, which are on southern exposure [4].

As a result of the pressures exerted by the climatic changes, it appeared the necessity of developing new varieties of vegetables, varieties resistant to drought, with shorter germination and vegetation period, with high carbon intake capacity etc.. Selecting the appropriate varieties aims firstly the efficiency of using natural and climatic resources, and secondly, the minimization of the impact of agricultural practices on the environment [19].

The ability to adapt to the current climatic conditions of onion, beans and pepper crops was monitored, considering significant parameters for the development of these crops. Analyzes were carried out on soil samples from onion, beans and pepper crops and the water used to irrigate from the study area, within the laboratories of the National Institute for Research and Development for Environmental Protection, Bucharest. The content of nutrients was analyzed, the amount of humus, soil pH and other elements that can influence the crops development. Also, the climatic data (air and soil temperature) were analyzed for the time span 1961-2013, in order to detect possible changes in their regime, considering that temperature is essential in crops growth. The adaptability of the varieties can be verified both by carrying out analyzes on soil and water, as well as by observations on the quantity and quality of the harvest analyzed over a time span.

3 Problem Solution

In the present paper, soil samples from onion, beans and pepper crops were analyzed, in terms of physical proprieties by particle size distribution using the sieving method. In all three cases, sandy and silt soil texture was identified (Fig. 2), which indicates that the soil texture from the study area meets the requirements of the analyzed crops, according to the relevant published literature. Usually, for the grain size distribution, it is used the Udden-Wentworth particle size scale, being the most used scale in sedimentology [15].

Soil samples were analyzed also by chemical properties (especially the nutrients content), in order to determine whether the quality complies with the standards of soil for agriculture and soil pollution, according to Order no. 756 of November 3, 1997 (table 1).

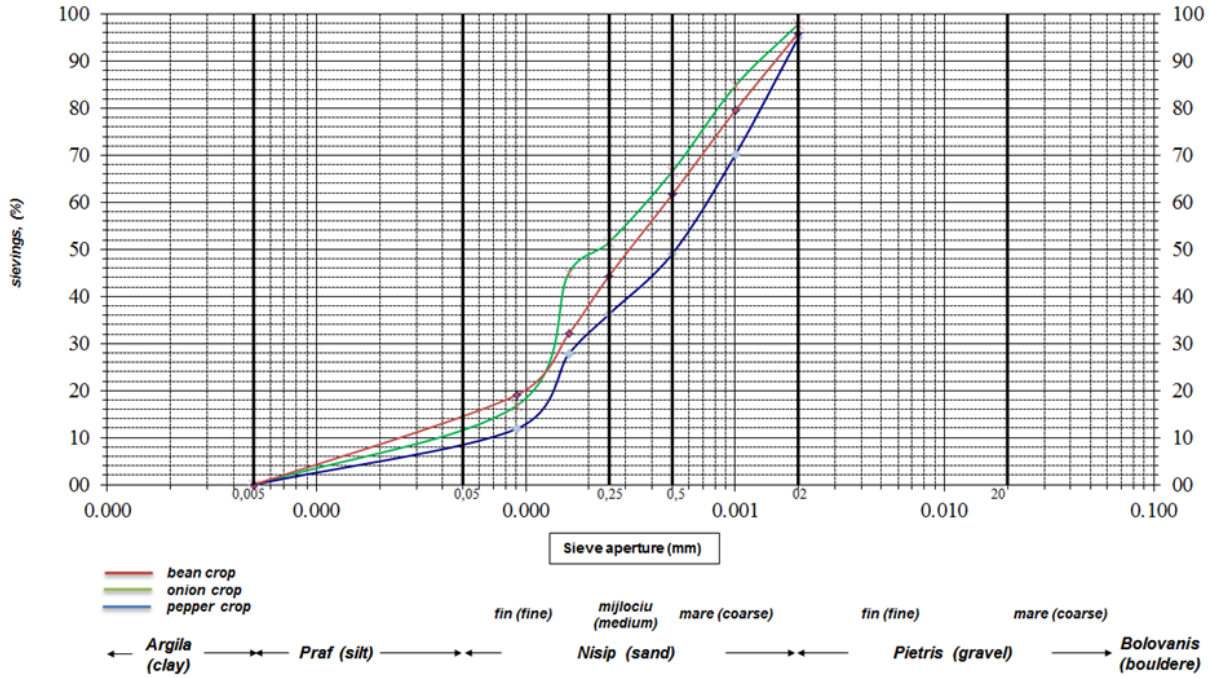

Fig. 2 Particle size distribution

Table 1. Chemical analysis results

Parameters	S1- onion crop	S2 – pepper crop	S3 – bean crop	Normal values	Alert treshold (intervention)
pH	7,72	7,83	7,89	7,3-8,4 (slightly alkaline)	-
Humus %	2,83	3,24	2,67	>2	-
N - nitrogen %	0,175	0,233	0,184	0,141-0,270 (medium content)	50.000
P- phosphorus %	0,114	0,123	0,102	-	5.000
Cu (mg/kg)	30,1	41,9	25,3	20	100
Pb (mg/kg)	25,3	33,5	14,4	20	50
Ni (mg/kg)	30,8	44,9	30,2	20	75
Zn (mg/kg)	89,4	102,3	85,3	100	300
Cr (mg/kg)	27,8	40,3	22	30	100
Sulphates (mg/l)	22,5	15,5	19,1	-	2000

S – soil sample.

The identified soil has a reaction (pH) slightly alkaline. This type of soil has a high favorability for onion crops, meeting the requirements of the crop. The amount of humus is low. This value is due to the lack of organic fertilization for the last 30-40 years [10]. As shown in table 1, the content of heavy metals does not exceed the alert threshold.

In the present paper, there has been also analyzed air and soil temperature data for time span 1961-2013. The soil temperature data was available from ROCADA database [9], while air temperature data was downloaded from Regional Basic Synoptic Network (RBSN). For this, the frequency distributions of average annual soil and air temperatures were analyzed, in order to detect possible changes in their regime. For soil temperature, as can be seen in the Figure 3 it appears that in the most cases the values range from 12 to 13 °C, while in the case of air temperature (Figure 4), temperature mostly varies between 11 and 12 °C.

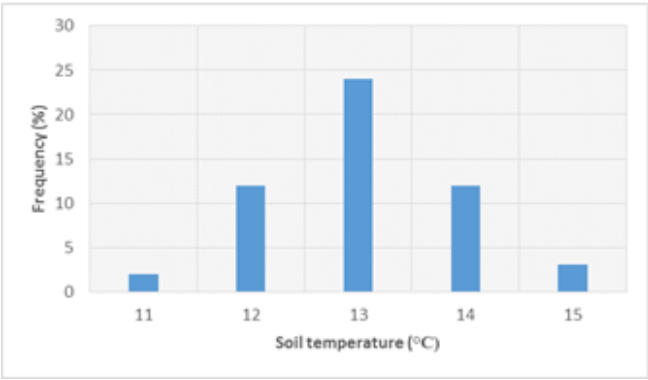

Fig. 3 Frequency distributions f annual average soil temperatures in Buzau per 1°C intervals

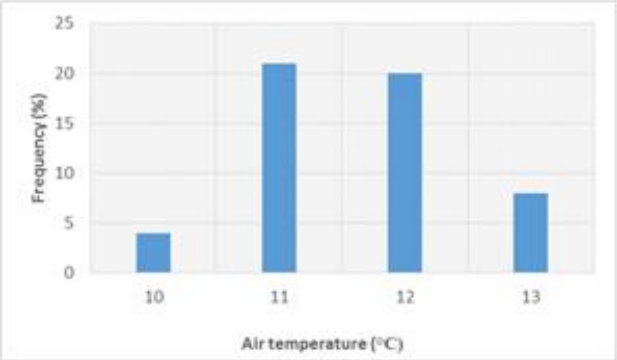

Fig. 4 Frequency distributions of annual average air temperatures in Buzau per 1°C intervals

Considering that rising temperatures can limit crops growth, in order to assess occurrence of the change for average annual air temperatures, in the Figure 5 bellow is presented the decennial evolution of the multiannual average air temperature at Buzau station. It can be seen that in the decade 2001-2010 is encountered the highest temperature (11,8 °C), value that is 1.2 °C higher than the lowest value recorded in the decade 1971-1980, when the multiannual average was 10,6 °C.

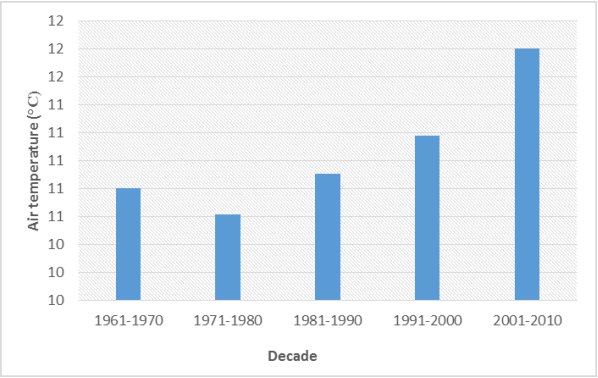

Fig. 5 The decennial evolution of the multiannual average air temperature at Buzau station

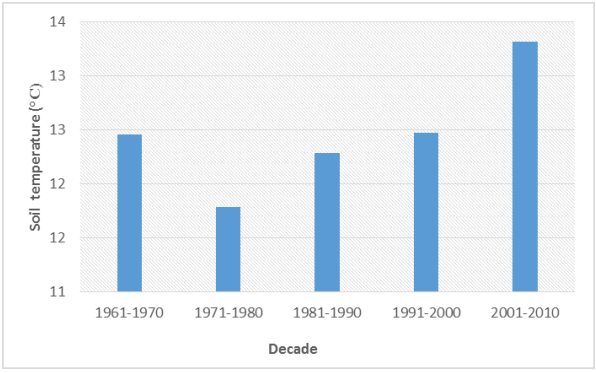

Fig. 6 The decennial evolution of the multiannual average soil temperature at Buzau station

More significant increases can be observed for soil temperature (Figure 6) so that in the decade 2001-2010 the recorded value was 13.3 °C. For this period, compared to the lowest value recorded in the decade 1971-1980, of 11.8 degrees, there can be noticed an increase of 1.5°C.

4 Conclusion

According to studies, Romania is and will be affected by the effects of climate change, the most common phenomenon being drought. Vegetable farming is considered a part of agriculture, which has been influenced in recent years by the negative effects of climate change affecting the quantity and quality of vegetables.

Different factors were analyzed that may affect the ability to adapt to different conditions, including climatic conditions, of certain cultures of onions, beans and peppers and of the water used for irrigation in the study area. The results from particle size distribution, showed that the soil has a sandy and silt texture, which corresponds to crop requirements according to the relevant published literature.

The air and soil temperature was analyzed for the time span 1961-2013. The frequency distributions of annual average soil and air temperatures were analyzed, in order to detect possible changes in their regime. According to the analysis it was identified that for the soil temperature, in most cases the values vary between 12°C and 13°C, and in the case of air, the temperatures mostly vary between 11 and 12°C.

Also, the decennial evolution of the multiannual average air temperature of Buzau station was analyzed and a temperature increase was observed between time span 2001-2010 compared with 1971-1980. The significant increase was identified on soil temperature.

According to the figures, there is an increase in temperatures, which affects crops. For this reason, the need to make new varieties that can withstand extreme temperatures increases year by year.

Chemically, the soil corresponds to the requirements of onion and bean crops with a high favorability in the analyzed area.

Acknowledgements

This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI-UEFISCDI project number 11/PCCDI/2018 within PNCDI III.

References:

[1] ANM-National Meteorological Administration, 2014, *Code of good agricultural practices, in*

the context of current and foreseeable climate change, ADER 2020, ADER 1.1.1.

[2] Apahidean, A.S. (2004), *The ecological characteristics of vegetable plants - water*

[3] Berke, T.G., L.L. Black, R.A. Morris, N.S. Talekar şi J.F. Wang (2003).*Suggested cultural practices for sweet pepper*. Asian Vegetable Reasearch and Development Center Publication, Shanhua, nr. 99-497R

[4] Brumă I. S., 2004, *Organic technologies for growing vegetables*, Editure „TERRA NOSTRA" Iaşi, România

[5] GASC-ANM -*Guide on adaptation to climate change* - National Meteorological Administration

[6] Chilom Pelaghia, 2002, *General vegetable culture*, Editure. Reprograph, Craiova

[7] Ciofu R., Stan N., Popoescu V., Chilom P., Apahidean S., Horgos., Berar V., Laure K. L, Anastasiu N., 2004, *Treated by vegetables*

[8] Deák Gy., Coman V., Matei M, Rotaru A.,Voicu M., Laslo L.,Lupei T.,Vladuț V.,Tudora C.,*Innovative technologies to reduce the negative impact of climate changes in vegetable crop*, (2019) INMATEH – Agricultural Engineering, pp.807-810

[9] Dumitrescu A., Birsan M., 2015, ROCADA: a gridded daily climatic dataset over Romania (1961–2013) for nine meteorological variables

[10] Dumitru M., Dumitru S., Tanase V., Mocanu V., Manea A., Vrinceanu N., Preda M., Efetene M., Ciobanu C., Calciu I., Rîsnoveanu I., 2011, *Soil quality monitoring in Romania*, National Research and Development Institute for Soil Science, Agrochemistry and Environment – ICPA

[11] Hoble A.G., 2011, *Summary of the PhD thesis Research on the influence of some technological factors in irrigation conditions, on the production of peppers grown in the field*

[12] Lindner M., 2017 ,*EIP-AGRI Focus Group Forest Practices & Climate Change*

[13] Lujerdean, A. si Bunea, A., 2005 - *Chemistry of water and soil - practical works*, Editure. Academic Pres –HUMUS

[14] MADR.ro,2014, *Organic farming* - Thematic publication no. 4 YEARS II

[15] Mateescu C., 1961, *Hydraulics*, Editure Pedagogica

[16] Mitof I., Prăvălie R., *Temporal trends of hydroclimatic variability in the lower Buzau catchment*, Geographia Technica, Vol. 09, Issue 1, 2014, pp 87 la 100

[17] Musat M., Burnichi F., Ciceoi R., Dobrin A., 2018, *Characterization of soil conditions in an organic testing field for vegetable crops*, Buzau county, Romania

[18] National Institute of Statistics - Statistical Yearbook of Romania 2007-2013

[19] National Research and Development Institute for Soil Science, Agrochemistry and Environment – ICPA-, National Meteorological Administration, University of Agronomic Sciences and Veterinary Medicine, Bucharest, 2014, *Guide to good agricultural practices for mitigating the effect of climate change on agriculture*

[20] Nikolova N., Mochurova M., 2012, *Chances in air temperature and precipitation and impact on agriculture* ,Volume XI, Issue 1 (June 2012), pp. 81-89

[21] Official site ANM, accesed at 07.05.2019 http://www.meteoromania.ro

[22] Order no. 767 of November 3, 1998, Regulations on the evaluation of environmental pollution

[23] Popandron 2012, *Modern technologies for obtaining onion bulbs*, Editure. Printech, Bucharest.

[24] Pauline F. D. Scheelbeek, Frances A. Bird, Hanna L. Tuomisto, Rosemary Green, Francesca B. Harris, Edward J. M. Joy, Zaid Chalabi, Elizabeth Allen, Andy Haines, and Alan D. Dangour, 2018, *Effect of environmental changes on vegetable and legume yields and nutritional quality*

[25] Popa N., 2017, *The influence of moisture on the beans*

[26] Popescu V., Horgos A., 2004, *Solano-fruit vegetable plants*

[27] Radu M., Ivanov., Ionescu P., Deak G., Diacu E., Ciobotaru., Ghita G., Marcu E., 2019, *Multivariate Statistical Characterisation of Soil Quality in the Lower Danube River Riparian Areas*, Revista de Chimie- Original Edition

[28] Stan N., Munteanu N., Stan T., 2003 *Vegetables*, Volume III, Editure "Ion Ionescu de la Brad"

[29] Soare E.; Dobre I.; David L.(2016), *Economic analysis in vegetable sector of Romania*; Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 16, Issue 4, PRINT ISSN 2284-7995, E-ISSN 2285-3952

[30] Serban D. (2010), *SCDL Buzau presents the Capriciu tomato variety, drought tolerant*

[31] www.buzau.insse.ro/, accessed at 11.06.2019

[32] www.madr.ro Official site, 2019

[33] http://www.insse.ro/cms/ Official site, 2019