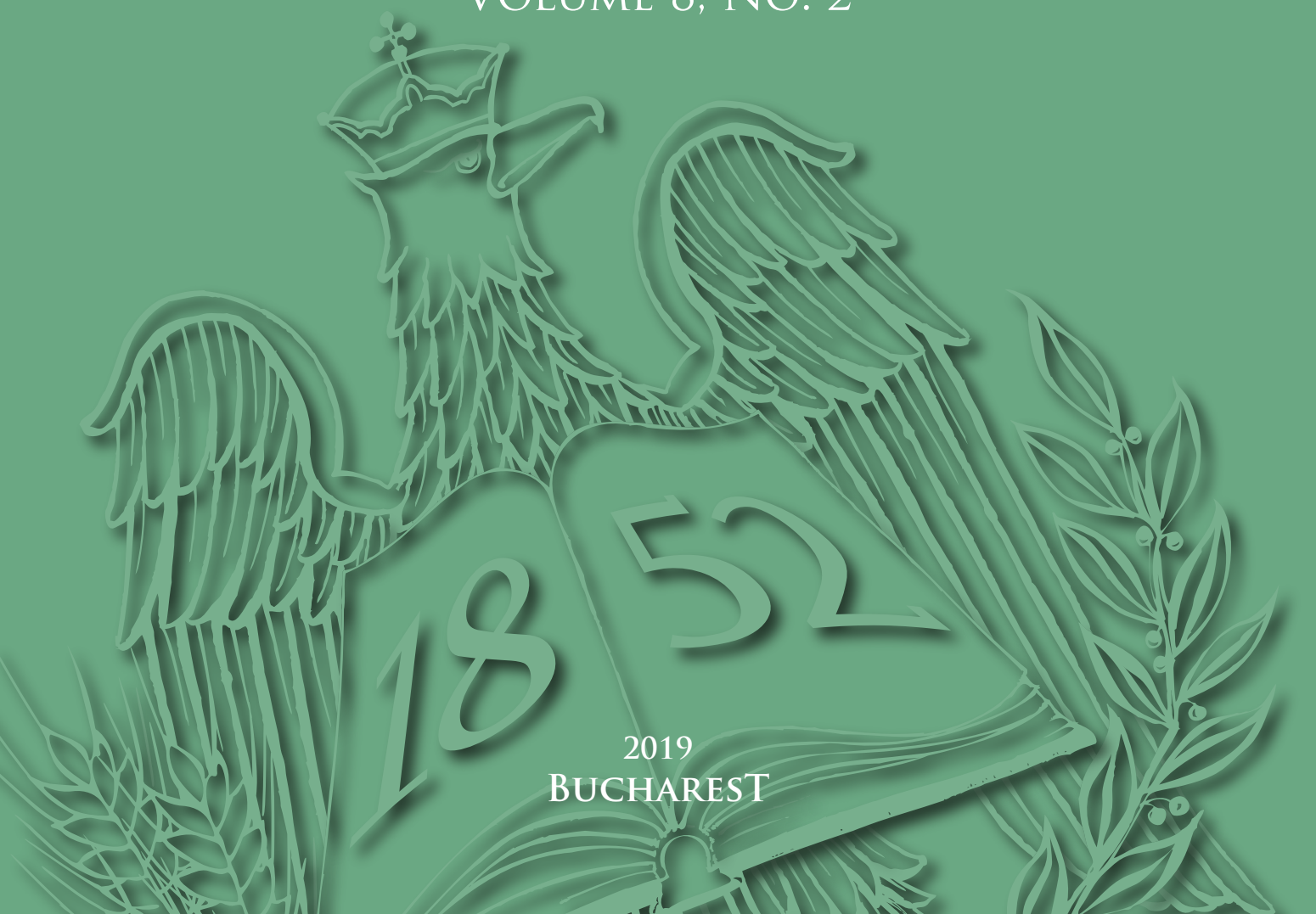
University of Agronomic Sciences
and Veterinary Medicine of Bucharest

AgroLife
Scientific Journal

Volume 8, No. 2



2019
BucharesT

AgroLife
Scientific Journal
Volume 8, No. 2, 2019

University of Agronomic Sciences
and Veterinary Medicine of Bucharest

AgroLife
Scientific Journal

Volume 8, No. 2

December, 2019
BucharesT

PUBLISHERS:

University of Agronomic Sciences and Veterinary Medicine of Bucharest
Address: 59 Mărăşti Blvd., District 1, Postal Code 011464, Bucharest, Romania
E-mail: agrolifejournal@usamv.ro; Webpage: http://agrolifejournal.usamv.ro

CERES Publishing House
Address: 29 Oastei Street, District 1, Bucharest, Romania
Phone: +40 21 317 90 23
E-mail: edituraceres@yahoo.com; Webpage:www.editura-ceres.ro

To be cited: AgroLife Sci. J. - Vol. 8, No. 2, 2019

ISSN 2285-5718; ISSN - L 2285-5718

EDITORIAL BOARD

CONTENTS

AgroLife Scientific Journal - Volume 8, Number 2, 2019
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

THE ECONOMIC EFFICIENCY OF SWEET CORN PRODUCTION IN THE SOUTH OF UKRAINE DEPENDING ON THE AGROTECHNOLOGY

Pavlo LYKHOVYD[1], Viktor USHKARENKO[2], Sergiy LAVRENKO[2], Nataliia LAVRENKO[2]

[1]Kherson State Agrarian University, Kherson, 23 Stritenska Street, 73006, Phone: 0552416216, Email: office@ksau.kherson.ua
[2]Institute of Irrigated Agriculture, Naddniprianske, Kherson, Ukraine, 73483, Phone: 0552361196, Email: izz.ua@ukr.net

Corresponding author email: agroworkmail@ukr.net

Abstract

The paper presents the results of the study devoted to the investigation of sweet corn economic efficiency production in dependence on the crop cultivation technology in the South of Ukraine. We studied the effect of basic plowing depth (20-22, 28-30 cm), mineral fertilization (no fertilizers, $N_{60}P_{60}$, $N_{120}P_{120}$), plant population (35,000, 50,000, 65,000, 80,000 plants ha^{-1}) in the irrigated conditions of the Steppe zone on the yield of ears with connection of this index to the economic profitability. It was determined that the highest productivity of the crop (10.93 t ha^{-1}) together with the highest profitability level (244.02%) was provided by the technological complex with plowing on the depth of 20-22 cm, mineral fertilizers application rate $N_{120}P_{120}$, plant population of 65,000 plants ha^{-1}. We recommend the above-mentioned cultivation complex as a basic one for the farmers of the South of Ukraine due to its high economic profitability and best out-pay of the expenditures.

Key words*: cultivation technology, economic indexes, profitability level, sweet corn.*

INTRODUCTION

Sweet corn (*Zea mays* L. ssp. *saccharata* Sturt.) is a valuable vegetable crop with an increasing demand on the market of European countries. The top producers of fresh sweet corn are USA, Hungary, France, Thailand etc. (Szymanek et al., 2005). The total value of sweet corn produced in the USA in 2016 reached 9 million USD (NASS, 2017).

Modern agrotechnologies have to provide high productivity of crops and excellent quality of the obtained product together with the best economic and resource efficiency (Aldrich et al., 1975). There are a number of studies devoted to the research of sweet corn yielding capacity at different agro-environmental conditions, various hybrids and cultivars, tillage practices, fertilization, plant population, sowing dates, pest and weed management, irrigation scheduling etc. (Akman, 2002; Al-Hurmuzi and Topak, 2018; Cruz et al., 2015; Garcia y Garcia et al., 2009; Kumar & Narayan, 2018; Makus, 2000; Shin et al., 2014; Uwah et al., 2011). However, very few of them pay special attention to the question of economic efficiency.

The goal of the paper is to present the results of the study devoted to the improvement of sweet corn cultivation technology elements for the drip-irrigated conditions of the South of Ukraine, including basic tillage, mineral fertilization and plant population options, and to recommend the farmers of the region the optimum agrotechnological complex for the best economic efficiency of the crop production.

MATERIALS AND METHODS

The field experiments devoted to the sweet corn cultivation technology improvement were carried out during 2014-2016 at the irrigated plots of the basic farm «Radianska Zemlia» located in the Steppe zone of Ukraine (latitude 46°43′N, longitude 32°17′E, 42 m above the sea level).

The soil of the experimental plots was represented by the dark-chestnut slightly solonetz soil with the content of humus 2.5%, low amounts of available for plants nitrogen,

medium amounts of mobile phosphorus, and high amounts of exchangeable potassium by the results of agrochemical survey conducted by the Institute of Soil Science. Bulk density of the soil is 1.22 g cm^{-3} in the layer 0-30 cm, and 1.35 g cm^{-3} in the layer of 0-100 cm.

Climate of the zone of experiments conduction is characterized as comparatively dry and hot, with the average annual air temperature of 9.8°C that has a tendency to further increase (Lykhovyd, 2018). According to the data provided by Kherson regional hydrometeorological center, total rainfall amounts in the zone average to 441 mm, while evapotranspiration reaches 1000 mm.

Weather conditions in the years of the trials conduction were quite typical for the Steppe zone of Ukraine. The years were different in the rainfall amounts: 2014 was the driest year, while 2015 was enormously humid with 99.6 mm more rainfall than annual norm. 2016 was the closest to the long-term annual norm in precipitation. Sweet corn vegetation was sufficiently supplied with heat: the sum of the effective temperatures above 10°C was 1960.1°C in 2014, 1799.6°C in 2015, and 1882.5°C in 2016, respectively. The design of the study foresaw an investigation of such elements of the crop cultivation technology: plowing depth (20-22 and 28-30 cm), mineral fertilization rates (no fertilizers, $N_{60}P_{60}$, $N_{120}P_{120}$), plant population (35,000, 50,000, 65,000 and 80,000 plants ha^{-1}). We used a randomized split plot design method to conduct the study in four replications.

Sweet corn cultivation technology based on the common recommendations for corn cultivation in the irrigated conditions of the Steppe zone of Ukraine. The cultivar 'Brusnytsia' (common sugary corn of *su* type) was used as a basic seed material for the experimental work. The previous crop (winter wheat) was harvested in the autumn, with double disking tillage and plowing following. Mineral fertilizers in the rates required by the design of the study were applied at the pre-plowing period. Sweet corn was sown by using the standard pneumatic seed drill on the depth of 5-6 cm with the inter-row spacing of 70 cm. Plant care was in the conduction of irrigation through the installed in advance drip system, and plant protection against insects (by using the allowed preparations of *lambda cehalothrin* and *chloranthraniliprole*) and weeds (by using the allowed preparations of *acetochlor* before the stage of germination and *foramsulfuron, iodosulfuron, thiencarbazone-methyl* during the vegetation). Total amount of irrigation water applied were 170 mm in 2014, 120 mm in 2015, and 160 mm in 2016, respectively. The water used for irrigation is characterized as limited suitable because of relatively high mineralization of 1.4-1.5 g l^{-1}, and sodium content of 45-50% that is not favorable for normal plant growth and may affect the fertility of soil (Lykhovyd and Kozlenko, 2018; Lykhovyd and Lavrenko, 2017).

The results of the yield evaluation were generalized and statistically processed by the means of multi-factor analysis of variance (ANOVA) at the probability level of 95% ($p<0.05$). The differences between the variants of the trials were significant. We used the recommendations of domestic scientists through the conduction of mathematical data processing (Ushkarenko et al., 2014).

The economic efficiency of sweet corn production was determined by using the standard methodology of calculation of the profitability level (Ushkarenko et al., 2014). Profitability level was calculated as the ratio of the obtained pure profit to the full expenditures required by the certain variant of cultivation technology.

RESULTS AND DISCUSSIONS

The results of our study proved that all the elements of sweet corn cultivation technology have significant effect on the yielding capacity of the crop. It was determined that the minimum yield was obtained at the variant with plowing on the depth of 20-22 cm, with no mineral fertilizers applied and at the plant population of 35,000 plants ha^{-1} - 2.67 t ha^{-1}, while the highest productivity of the crop was guaranteed by the maximum mineral fertilizers rate of $N_{120}P_{120}$ at the plant population of 65,000 plants ha^{-1} - 10.93 t ha^{-1} or 4.09 times higher (Table 1).

The least significant difference (LSD) at the probability level of 95% was evaluated as 0.32 t ha^{-1}, so, all the variants are significantly different from each other (Table 1).

Table 1. Sweet corn yield in the marketable ears without husks in dependence on the cultivation technology, t/ha

Plowing depth, cm	Mineral fertilizers rates, kg ha^{-1}	Plant population, plants ha^{-1}	Yield of marketable ears, t ha^{-1}
20-22	No fertilizers	35,000	2.67
20-22	No fertilizers	50,000	2.85
20-22	No fertilizers	65,000	3.01
20-22	No fertilizers	80,000	2.96
20-22	$N_{60}P_{60}$	35,000	5.56
20-22	$N_{60}P_{60}$	50,000	6.31
20-22	$N_{60}P_{60}$	65,000	7.67
20-22	$N_{60}P_{60}$	80,000	6.80
20-22	$N_{120}P_{120}$	35,000	7.53
20-22	$N_{120}P_{120}$	50,000	8.81
20-22	$N_{120}P_{120}$	65,000	10.93
20-22	$N_{120}P_{120}$	80,000	9.58
28-30	No fertilizers	35,000	3.00
28-30	No fertilizers	50,000	3.34
28-30	No fertilizers	65,000	3.57
28-30	No fertilizers	80,000	3.37
28-30	$N_{60}P_{60}$	35,000	4.89
28-30	$N_{60}P_{60}$	50,000	5.55
28-30	$N_{60}P_{60}$	65,000	6.25
28-30	$N_{60}P_{60}$	80,000	5.64
28-30	$N_{120}P_{120}$	35,000	6.23
28-30	$N_{120}P_{120}$	50,000	7.36
28-30	$N_{120}P_{120}$	65,000	8.59
28-30	$N_{120}P_{120}$	80,000	7.56
LSD_{05} ($p < 0.05$, probability level of 95%)			0.32

Source: The results of own study conducted during 2014-2016

It was determined that increase of the plowing depth is justified only under the non-fertilized conditions of the crop cultivation, while application of mineral fertilizers makes this agrotechnological measure ineffective.

The highest increase in the yields of sweet corn was provided by the application of higher rates of mineral fertilizers. Plant population increase is justified only to the certain level, which was 65,000 plants ha^{-1} in our study. Further increase of the quantity of plants per the unit of area caused significant loss of the crop productivity.

The results of economic analysis of sweet corn production in the trials showed that the crop remains profitable even at the worst productivity level of 2.67 t ha^{-1} (the profitability level in this case is 16.98%). The best profitability level of sweet corn production was provided by the variant with plowing depth of 20-22 cm, mineral fertilizers application rate of $N_{120}P_{120}$ and the plant population of 65,000 plants ha^{-1} - 244.02% (Table 2).

Table 2. Profitability level of sweet corn production in dependence on the cultivation technology

Plowing depth, cm	Mineral fertilizers rates, kg ha^{-1}	Plant population, plants ha^{-1}	Profitability level, %
20-22	No fertilizers	35,000	16.98
20-22	No fertilizers	50,000	23.22
20-22	No fertilizers	65,000	28.45
20-22	No fertilizers	80,000	25.36
20-22	$N_{60}P_{60}$	35,000	110.90
20-22	$N_{60}P_{60}$	50,000	133.58
20-22	$N_{60}P_{60}$	65,000	173.70
20-22	$N_{60}P_{60}$	80,000	145.34
20-22	$N_{120}P_{120}$	35,000	155.78
20-22	$N_{120}P_{120}$	50,000	190.41
20-22	$N_{120}P_{120}$	65,000	244.02
20-22	$N_{120}P_{120}$	80,000	206.75
28-30	No fertilizers	35,000	30.07
28-30	No fertilizers	50,000	42.37
28-30	No fertilizers	65,000	50.03
28-30	No fertilizers	80,000	41.04
28-30	$N_{60}P_{60}$	35,000	87.75
28-30	$N_{60}P_{60}$	50,000	108.26
28-30	$N_{60}P_{60}$	65,000	129.23
28-30	$N_{60}P_{60}$	80,000	108.12
28-30	$N_{120}P_{120}$	35,000	116.36
28-30	$N_{120}P_{120}$	50,000	148.64
28-30	$N_{120}P_{120}$	65,000	181.54
28-30	$N_{120}P_{120}$	80,000	151.12

Source: The results of own study conducted during 2014-2016

It is interesting to compare our results with the results obtained in similar studies by other foreign and domestic researchers. There is little information in regard to the economic effects of tillage practice on the economic efficiency of sweet corn production. However, it was proved that tillage minimization usually has a positive effect on the economic indexes in comparison to conventional deep tillage (Zurovec et al., 2017). The results of our study are in agreement with this statement: the best profitability of sweet corn cultivation was provided by the variant with usual plowing, not deep.

Scientists proved that rational scientifically substantiated application of Nitrogen fertilizers at the corn crops result in considerable increase of the crop cultivation efficiency from the economic point of view (Mulvaney et al., 2006). We saw the above-mentioned tendency in our study: the variants with higher rates of mineral fertilizers applied to the field were more efficient economically. However, some researchers point out that there is no need to over-fertilize the crop, the best way is to apply the optimum dose of Nitrogen and obtain the best compromise between the yields and economic efficiency (Vanotti and Bundy, 1994). It is highly likely that this statement is true. But we did not have the variant of over-fertilization, so, we cannot verify or debunk this information. Besides, we have to mention that sweet corn is highly responsive to fertilization independently on the features of genotype that is very important because it makes possible to extrapolate the results of the studies conducted with different hybrids and varieties of the crop on other genotypes (Mullins et al., 1999).

Plant population is also an important factor of economic efficiency increase. It was stated that the effect of this parameter of agrotechnology differs in different genotypes of sweet corn: some genotypes provided the best economic efficiency at 40,000 plants ha^{-1}, while others performed better at 50,000 plants ha^{-1}, depending mostly on the duration of vegetative period (Yakunin et al., 2011). This report is supported by another scientific result that testify about the optimum plant population of sweet corn decrease from 50,000 to 30,000 plants ha^{-1} with the increase of duration of the hybrids' vegetative period (Okselenko, 2010). The results of our study did not take into account the effect of cultivar on the economic efficiency. The results of Eskandarnejad et al., 2013 report that the best plant population for sweet corn in the conditions of Iran is 90,000 plants ha^{-1} in comparison to 60,000 and 75,000 plants ha^{-1}. The study by Morris et al., 2000 discovered that the yield of sweet corn increased with the increase of plant population in from 29,600 to 69,200 plants ha^{-1} in all the studied varieties and hybrids. Both of the above-mentioned studies did not have the variant of over-population. However, there is a study that is in agreement with our results, namely, that the yield of sweet corn increases up to the certain number of plants ha^{-1}, and further thickening of crops has negative effect on the productivity. The best plant population in the above-mentioned study for fresh-market sweet corn was considered to be 56,000 plants ha^{-1} (Nichols, 1974).

It is evident that the optimum plant population, tillage and fertilization options for the best efficiency of sweet corn production are highly dependent on the features of the cultivated hybrids and environmental conditions. That is why it is important to conduct research work in this field for every particular zone of the crop cultivation taking into account the assortment of varieties and hybrids, environmental, climatic, soil conditions, and the level of agriculture in the area.

CONCLUSIONS

The results of economic analysis of sweet corn agrotechnology testified that the best economic efficiency of the crop production is provided by the complex of technological operations including moldboard plowing at the depth of 20-22 cm, application of mineral fertilizers in the rate of $N_{120}P_{120}$, and plant population of 65,000 plants ha^{-1}. This agrotechnological complex provided the maximum profitability level of 244.02%.

Therefore, we recommend cultivation of sweet corn for the fresh market needs in the Steppe zone in the drip-irrigated conditions by using the above-mentioned technological operations that will guarantee high economic effect of the crop production for farmers.

However, we have to mention that our study does not take into account a number of other important agrotechnological factors of sweet corn productivity and economic efficiency. Therefore, we are going to conduct additional researches to provide scientific community and agricultural producers with more comprehensive scientifically based information in regard to the efficient cultivation of the crop in the irrigated conditions of the Steppe zone.

REFERENCES

Akman, Z. (2002). Effect of tiller removing and plant density on ear yield of sweet corn (*Zea mays saccharata* Sturt). Pakistan Journal of Biological Sciences, 5(9), 906-908.

Aldrich, S.R., Scott, W.O., Leng, E.R. (1975). Modern corn production, second ed. A&L Publications, Champaign, IL.

Al-Hurmuzi, J.O.H., Topak, R. (2018). Lateral spacing affect on yield and quality attributes of drip-irrigated sweet corn. Selcuk Journal of Agricultural and Food Sciences, 32(1), 55-59.

Cruz, C.A., Filho, A.B.C., Meneses, N.B., da Cunha, T.P.L., Nowaki, R.H.D., Barbosa, J.C. (2015). Influence of amount and parceling of nitrogen fertilizer on productivity and industrial revenue of sweet corn (*Zea mays* L.). Australian Journal of Crop Science, 9(10): 895-900.

Eskandarnejad, S., Khorasani, S.K., Bakhtiari, S., Heidarian, A.R. (2013). Effect of row spacing and plant density on yield and yield components of Sweet corn (*Zea mays* L. *saccharata*) varieties. Advanced Crop Science, 3(1), 81-88.

Garcia y Garcia, A., Guerra, L.C., Hoogenboom, G. (2009). Water use and water use efficiency of sweet corn under different weather conditions and soil moisture regimes. Agricultural Water Management, 96(10), 1369-1376.

Kumar, A., Narayan, A. (2018). Influence of planting methods, spacing and fertilization on yield and quality of sweet corn (*Zea mays* L.). International Journal of Current Microbiology and Applied Sciences, 7, 1232-1237.

Lykhovyd, P.V. (2018). Global warming inputs in local climate changes of the Kherson region: current state and forecast of the air temperature. Ukrainian Journal of Ecology, 8(2), 39-41.

Lykhovyd, P.V., Kozlenko, Y.V. (2018). Assessment and forecast of water quality in the River Ingulets irrigation system. Ukrainian Journal of Ecology, 8(1): 350-355.

Lykhovyd, P.V., Lavrenko, S.O. (2017). Influence of tillage and mineral fertilizers on soil biological activity under sweet corn crops. Ukrainian Journal of Ecology, 7(4), 18-24.

Makus, D.J. (2000). Performance of two sweet corn cultivars grown under conservation tillage and within-row weed pressure. Subtropical Plant Science, 52, 18-22.

Morris, T.F., Hamilton, G., Harney, S. (2010). Optimum plant population for fresh-market sweet corn in the Northeastern United States. Hort Technology, 10(2), 331-336.

Mullins, C.A., Straw, R.A., Pitt, Jr.B., Onks, D.O., Mullen, M.D., Reynolds, J., Kirchner, M. (1999). Response of selected sweet corn cultivars to nitrogen fertilization. HortTechnology, 9(1), 32-35.

Mulvaney, R.L., Khan, S.A., Ellsworth, T.R. (2006). Need for a soil-based approach in managing nitrogen fertilizers for profitable corn production. Soil Science Society of America Journal, 70(1), 172-182.

Nichols, M.A. (1974). A plant spacing study with sweet corn. New Zealand Journal of Experimental Agriculture, 2(4), 377-379.

Okselenko, O.M. (2010). Growth, development and yields of sweet corn hybrids of different groups of ripeness depending on the plants density. Messenger of Dnipropetrovsk State Agrarian University, 1, 19-22.

Shin, S., Lee, J.S., Son, B.Y., Kim, J.T., Kim, S.G., Kim, M.J., Kim, S.L., Kwon, Y.U., Baek, S.B., Woo, M.O., Bae, H.H. (2014). Effect of plant density on growth and yield of extremely late-planted korean sweet corn hybrids (*Zea mays* L.) for fresh market. Journal of Crop Science and Biotechnology, 17(4), 289-295.

Szymanek, M., Dobrzański, B., Niedziółka, I., Rybczyński, R. (2005). Sweet corn: harvest and technology, physical properties and quality. B. Dobrzański Institute of Agrophysics Polish Academy of Sciences.

Ushkarenko, V.O., Kokovikhin, S.V., Holoborodko, S.P., Vozhehova, R.A. (2014). Methodology of the field experiment (Irrigated agriculture): The textbook, Kherson.

Uwah, D.F., Eneji, A.E., Eshiet, U.J. (2011). Organic and mineral fertilizers effects on the performance of sweet maize (*Zea mays* L. *saccharata* strut.) in south eastern rainforest zone of Nigeria. International Journal of Agricultural Sciences, 3(1), 54-61.

Vanotti, M.B., Bundy, L.G. (1994). An alternative rationale for corn nitrogen fertilizer recommendations. Journal of Production Agriculture, 7(2), 243-249.

Yakunin, O.P., Okselenko, O.M., Zavertaliuk, V.F., Bielikov, Y.I. (2011). Agroeconomic efficiency of cultivation of sweet corn hybrids in dependence on the plants density. Bulletin of the Institute of Grain Farming, 40, 85-87.

Zurovec, O., Kumar, Sitaula, B., Custovic, H., Zurovec, J., Dorsch, P. (2017). Effects of tillage practice on soil structure, N_2O emissions and economics in cereal production under current socio-economic conditions in central Bosnia and Herzegovina. PLoS ONE, 12, e0187681.

***National Agricultural Statistics Service (NASS), 2017.