Bulgarian Journal of Agricultural Science, 28 (No 1) 2022, 89–95

The impact of varieties, inter-row spacing and doses of fertilizers on fruit productivity and effectiveness of pumpkin production in the South of Ukraine

Gennadiy Karashchuk[1], Vadym Ilchuk[1] and Sergiy Lavrenko[1*]

Kherson State Agrarian and Economic University, Kherson 73006, Ukraine
[*]*Corresponding author:* lavrenko.sr@gmail.com

Abstract

Karashchuk, G., Ilchuk, V. & Lavrenko, S. (2022). The impact of varieties, inter-row spacing and doses of fertilizers on fruit productivity and effectiveness of pumpkin production in the South of Ukraine. *Bulg. J. Agric. Sci., 28 (1)*, 89–95

The paper presents the results of the research on the impact of doses of mineral fertilizers and inter-row spacing on fruit productivity of pumpkin. The research was conducted in 2017-2019 in dark-chestnut slightly alkaline soils. The experiment scheme included the following factors and their variants: the varieties Yanina, Dolia, Rodzynka; the inter-row spacing: 70 cm, 140 cm, 210 cm; the doses of fertilizers: without fertilizers, $N_{30}P_{30}$, $N_{60}P_{60}$, $N_{90}P_{90.}$. The experimental data were processed by the standard ANOVA procedure within MS Excel software. A steady level of fruit productivity of pumpkin with high economic indexes in the South of Ukraine is reached when growing the varieties Dolia and Rodzynka with the inter-row spacing of 140 and applying $N_{60}P_{60}$. We established that the application of these techniques allows achieving the fruit productivity at the level of 25-30 t/ha, the net profit being 63024 and 78026 UAH/ha, and the level of profitability being 165.1 and 201.2%.

Keywords: pumpkin; doses of fertilizers; varieties; inter-row spacing; productivity; economic efficiency

Introduction

Muscat pumpkin (*Cucurbita moschata* Duch. ex Poir.) is the most valuable among other pumpkin types by its taste characteristics, with tender fibers and very sweet flesh. This crop can be successfully grown in southern regions of Ukraine provided that basic agro-ecological elements of crop production technologies are developed and improved, the population is provided with environmentally friendly products, which not only have prophylactic, therapeutic and dietary effects, but are also enriched with biologically active substances.

Pumpkin exhibits medicinal properties on the human and animal (Bai et al., 2020; Rohman. & Irnawati, 2020; Rouag et al., 2020).

Pumpkin is a crop that can be grown as monospecies or mixed with corn (Momirović et al., 2015).

Over the past decade there has been a steady global tendency for an increase in pumpkin production. It is mainly caused by the fact that it is a highly productive crop and is very popular, in Ukraine in particular (Koltunov et al., 2016a; Rohman & Irnawati, 2020).

The correct selection of varieties for growing is also influenced by the nutrient content of the pumpkin. This is indicated by numerous studies of scientists (Aktaş et al., 2018; Assous et al., 2014; Chu et al., 2020; Lalnunthari et al., 2020; Loy, 2004; Mehditabar et al., 2020; Quijano-Ortega et al., 2020; Zhao et al., 2015).

The volumes of pumpkin production in the world make about 20 million tons. There is a steady tendency for an increase in this crop production because of its high productivity, and it is extremely important under conditions of an impending global food crisis. Ukraine enters the top 10 coun-

tries – the largest pumpkin producers in the world taking the 8th place. However, whereas China, taking the 1st place, annually grows 6056 thousand tons of pumpkin on average and Russia (the 3rd place) – 1076 thousand tons, Ukraine grows only 502 thousand tons, i.e. 12 times less than China does and 2.14 times less than Russia does. Calculated per capita, the superiority of these countries decreases considerably in favor of Ukraine.

Over the past decade the biggest increase in pumpkin production (31.7%) has been observed in Ukraine. 5 regions, located in the South and in the East of the country (Dnipropetrovsk, Donetsk, Mykolaiv, Kharkiv and Kherson regions), i.e. in the steppe and the forest-steppe zones, grow 37% of the gross harvest. One of the problems of sufficient pumpkin production and even provision of the market with high-quality, transportable, long-lasting and competitive fruits by a complex of characteristics not only for the domestic, but also for international trade is appropriate selection of varieties, adapted to particular soil and climate zones of Ukraine (Koltunov et al., 2016a).

Appropriate selection of pumpkin types and varieties allows planning the time of using fruits for food considering their expiration date (Sych, 2016).

The most important characteristic of a variety for large-scale production is its high adaptiveness to certain soil and climate conditions (Lavrenko et al., 2021).

Lately there has been not only an active process of creating pumpkin varieties for different purposes, but also improvement of the growing techniques.

The research on the development of growing techniques for pumpkin production mainly focuses on the issues of evaluating preceding crops, applying growth stimulators and plant protection measures, different methods of pre-sowing seed preparation, doses and ratios of mineral fertilizers, examining nutrition area (Yevtushenko **&** Romanov, 2018).

For instance, when planting pumpkin the size of nutrition area also depends on soil and climate conditions, in particular, on the amount of precipitation (Belik, 1982).

Nutrition area is determined on the basis of environmental conditions and biological characteristics of a variety. It is larger in dry areas than in the zones with higher moisture supply (Ladychuk et al., 2021). Under conditions of the Southern Steppe naked seed pumpkin is planted with the inter-row spacing of 1.4 and 2.1 m and the plant spacing – 0.7-1.4 m (Maidaniuk, 2016).

Wide-row seeding methods with the inter-row spacing of 140, 180 and 280 cm are the most common. The scheme of placing plants when growing pumpkin varieties with a long vine in the Southern Steppe of Ukraine is 210 cm (Serhienko, 2017).

It is necessary to mention that melons as sun loving plants, produce high yields under conditions of optimal nutrition area and density, sufficient light on fertilized fields. They react to changes in plant nutrition area, moisture supply and nutrients very rapidly (Kiendler, 1997).

Doses of fertilizers and ratios of mineral nutrition elements are determined considering soil fertility, the content of mobile nutrients, fertilizers applied when growing preceding crops and biological characteristics of plants (Maidaniuk, 2012; Ekanem & Akpheokhai, 2019; Juknevičienė et al., 2019).

Appropriate application of fertilizers for melons contributes to a considerable increase in their yields, accelerates fruit ripening and also improves their quality in all the soil and climate zones of the country (Lykhatskyi, 2002).

Growing pumpkins, like any other crop is not possible without the use of fertilizers. Currently, the maximum effect producers can get from the application of mineral fertilizers (Studstill et al., 2003).

In Southeastern Nigeria the maximum yield of 21.76 t/ha of pumpkin fruit was obtained at an application rate of 20 t/ha of poultry manure (Agu, 2004).

Mineral fertilizers for pumpkin are applied locally at the dose of $N_{30}P_{45}K_{30}$. It is a half of the recommended dose that corresponds to the concept of applying mineral fertilizers under current economic conditions (Knysh, 2018).

The experiment carried out in University of Baghdad included two factors, first was irrigation with normal water (A1), irrigation with magnetized water 500 gauss (A2) and the second factor included six levels of fertilizers are: control (without fertilization) (F1), chemical fertilization (Recommended) (F2), fertilization with mushrooms waste 5%(F3), 7.5% (F4), fertilization with poultry manure 5% (F5), 7.5% (F6). Highest yield of the fruits was at treatment F2 with A1 and F6 with A2 in open field (40.0, 33.5 t/ha respectively) and treatment F5 with A1 in green house (29.7 t/ha) (Almrani et al., 2016).

Research conducted at the University Obafemi Volvo, Ile-Ife, Nigeria showed that for the best dose of mineral fertilizers (NPK) for pumpkin is 180 kg/ha (Oloyede, 2012; Oloyede et al., 2012).

Research in northern Nigeria has shown that «Ta gidan gona» is the best pumpkin variety to grow. NPK (20-10-10) application at a dose of 450 kg/ha contributed to the formation of maximum vine length, leaf area index (LAI), and fruit circumference (Lawal et al., 2009).

In the South of Ukraine the application of the mineral fertilizers $N_{40\text{-}90}P_{60\text{-}90}K_{40\text{-}60}$ in autumn plowing has the greatest effect (Maidaniuk, 2016).

Materials and Methods

The experiments were conducted on the experimental plots of the LLC "TH Dolynske" in Chaplynka district of Kherson region. The experimental plots are located at the 46º26'48"N, 33º41'53" E. The elevation is 26 m.

The following factors and their variants were included in the research scheme:

– A – Muscat pumpkin variety: A1 – Yanina; A2 – Dolia; A3 – Rodzynka;

– B – inter-row spacing: B1 – 70 cm; B2 – 140 cm; B3 – 210 cm;

– C – doses of fertilizers: C1 – without fertilizers, C2 – $N_{30}P_{30}$, C3 – $N_{60}P_{60}$, C4 – $N_{90}P_{90}$.

The research was conducted in dark-chestnut slightly alkaline soil with the content of mobile nitrogen – 6.6, mobile phosphorous 36.0, mobile potassium – 422.0 mg/kg in the soil layer of 0-30 cm on average for three years of the research. The topsoil tilth is characterized by the following agrochemical parameters: humus content is 1.75-1.91, pH of salt extract is 7,4.

Growing techniques used in the research were common for the zone of the Southern Steppe of Ukraine, except the factors under study. Winter wheat was a preceding crop.

After harvesting the preceding crop, the stubble was removed in two steps. In autumn tilling was performed to the depth of 25-27 cm.

In spring, when the soil was physically mature, early spring harrowing was performed in two directions to the depth of 4-6 cm. According to the research scheme, mineral fertilizers were broadcast in deep cultivation to the depth of 12-14 cm. Pre-sowing cultivation was performed to the depth of planting a seed.

The characteristics of the varieties under study:

Yanina. The country of origin: Ukraine. The purpose of using: versatile. Muscat pumpkin with the growing season of 105 days. The fruit is elongated-oval and short-oval, slightly ribbed, orange. Fruits are formed on the main stem. The average fruit weight is 6.5 kg, the fruit yield on the dry land is 25.4 t/ha. The weight of 1000 seeds is 150-170 g. The flesh is orange, thick, juicy and sweet. The dry matter content is 11%. The seeds are of a cream color with a distinct contour, medium size. The variety is long-lasting – up to 3.5 months, relatively resistant to powdery mildew.

The year of registration: 2005. The breeder of the variety: the Institute of the Southern vegetable and melon growing of the NAAS of Ukraine. The owner of the right to spread the variety: the Institute of the Southern vegetable and melon growing of the NAAS of Ukraine. The recommended zone for growing: the Forest Steppe, Polissia and the Steppe.

Dolia. The country of origin: Ukraine. The purpose of using: versatile. The method of creating the variety: cross pollination. The maturation time: 125-130 days. The fruit weight: 4-6 kg. The productivity: 20.0-40.0 t/ha. The fruit shape: elongated cylindrical. The fruit color: that of unripe fruits is green, that of ripe fruits is yellow. The flesh color is bright orange. The resistance to diseases: the variety is relatively resistant to diseases. The peculiarities: the taste characteristics are excellent, it is the best variety for long-term storage.

The year of registration: 2010. The breeder of the variety: Dnipropetrovsk Research Station of the Institute of the Southern vegetable and melon growing of the NAAS of Ukraine. The owner of the right to spread the variety: Dnipropetrovsk Research Station of the Institute of the Southern vegetable and melon growing of the NAAS of Ukraine. The recommended zone for growing: the Forest Steppe, Polissia and the Steppe.

Rodzynka. The country of origin: Ukraine. The variety of muscat pumpkin. The method of creating the variety: cross pollination. The growing season is 120–125 days. Transportable, a long-lasting variety of a muscat type with a large branchy vine.

The fruits are elongated-cylindrical with a thickened base, the average weight is 3–4 kg. The flesh is light orange, juicy and sweet. Medium resistant to powdery mildew. The variety is meant for cooking. The fruits are used fresh, boiled or fried and for squash juice.

The experimental data were processed by the standard procedure of ANOVA within MS Excel software. Significance of the differences was proved for the reliability level of 95% (LSD_{05}).

The year of registration: 2014. The breeder of the variety: the Institute of the Southern vegetable and melon growing of the NAAS of Ukraine. The owner of the right to spread the variety: the Institute of the Southern vegetable and melon growing of the NAAS of Ukraine. The recommended zone for growing: the Steppe.

The seeds of the pumpkin varieties were planted in the first decade of May with a wide row method with the inter-row spacing according to the experiment scheme. The planting density was at the rate of 9 thousand pieces of plants per hectare in all the variants of the experiment.

The plant care after the emergence of seedlings and prior to leaf overlapping in the inter-row spacing included two inter-row cultivations and manual weeding in the rows.

The crop was harvested at the stage of fruit industrial ripeness. The fruits were harvested in one step from the plots in each replication manually.

Meteorological indexes in the years of the research (2017-2019) entirely reflected the characteristic of the

Table 1. Meteorological indexes during the growing season of *Cucurbita moschata* Duch. ex Poir. in the field experiments (the meteorological station "Askania Nova" in Chaplynka district of Kherson region)

2017			2018			2019			Months
AT, ºC	PA, mm	RH, %	AT, ºC	PA, mm	RH, %	AT, ºC	PA, mm	RH, %	
15.9	8.5	62	18.9	18.7	60	17.4	42.4	72	May
22.0	9.4	55	22.4	11.0	53	24.5	14.1	56	June
23.5	62.4	56	24.3	36.9	64	23.3	61.7	54	July
25.2	33.0	48	25.1	0	44	23.3	47.6	53	August
19.4	13.7	63	18.7	19.5	60	17.5	39.6	56	September

Note: AT – air temperature; PA – precipitation amounts; RH – relative humidity.

Southern Steppe of Ukraine by weather conditions, that allowed obtaining reliable experimental data, drawing conclusions and make recommendations to agricultural producers of the region (Table 1).

In the growing season of pumpkin in 2017 the air temperature was 21.2ºC, that is higher by 2.0ºC than the average multi-year data of the growing zone. This year of the research was characterized by soil moisture deficit. The amount of precipitation was 127 mm, that was less by 56 mm than the multi-year indexes (the standard index is 183 mm). This index had an impact on the relative humidity being 57% in this period.

The weather conditions of the growing season of 2018 indicate to a hot climate. The average daily air temperature was 21.9ºC and was higher by 2.7ºC than the multi-year indexes. In addition to high temperature we registered little precipitation in this period – 86.1 mm (47.0% of the norm). The relative humidity in that year of the research was 56%.

The most favorable period for the growth, development and yield formation was the growing season of 2019, when the air temperature was 21.2ºC (the norm is 19.2ºC) on average in the growing season of pumpkin. The amount of precipitation exceeded the multi-year indexes by 112.2% being 205.4 mm under the relative humidity of 58%.

Results and Discussions

Yields with high economic and marketable commodity indexes are possible only under conditions of optimal combination of life factors, basic biological and agricultural laws. A plant can fully realize its genetic potential of growth, development, productivity and ability to last long only under conditions of optimal supply of all life factors. Consumption characteristics and matrical stability of a variety mainly depend on abiotic factors in combination with anthropogenic factors (agro-technical, harvesting, storage etc) (Koltunov, 2016a).

The basis for the formation of commodity quality of fruits is soil and climate conditions approximated to optimal conditions corresponding to their biological requirements, since the ultimate amount and quality of yields are total manifestation of different soil, meteorological, agro-technical and other impacts and effects during the entire cycle of ontogenesis (Koltunov et al., 2016b).

The results of our experiments allowed establishing that, on average in 2017–2019 the fruit productivity of the variety Dolia was 16.1–26.7 t/ha depending on the inter-row spacing and doses of fertilizers (Table 2). The productivity of the variety Yanina was lower by 6–20% depending on the factors under study, in comparison with the variety Dolia.

The highest fruit productivity was characteristic of the variety Rodzynka being 19.2–30.3 t/ha depending on the dose of fertilizers and the inter-row spacing, that is higher by 2.9–4.1 t/ha than that of the variety Dolia and by 5.1–5.9 t/ha than that of the variety Yanina.

Table 2. Fruit productivity of pumpkin depending on varieties, inter-row spacing and doses of fertilizers, t/ha (the average in 2017-2019)

Variety (A)	Inter-row spacing, cm (B)	Dose of fertilizers (C)			
		C1	C2	C3	C4
A1	B1	13.4	17.1	20.2	21.3
	B2	15.5	20.0	23.7	25.2
	B3	14.3	19.0	22.8	24.4
A2	B1	16.1	19.9	22.5	23.7
	B2	17.3	21.7	25.3	26.7
	B3	15.7	20.5	24.4	26.0
A3	B1	19.2	22.8	26.1	27.1
	B2	21.0	25.6	29.2	30.3
	B3	19.8	24.3	28.2	29.8
LSD_{05}	A	0.60			
	B	0.60			
	C	0.69			
	AB	1.04			
	AC	1.20			
	BC	1.20			
	ABC	2.08			

Table 3. The cost price of 1 t of pumpkin fruits depending on varieties, inter-row spacing and doses of fertilizers, UAH (the average in 2017-2019)

Variety (A)	Inter-row spacing, cm (B)	Dose of fertilizers (C)			
		C1	C2	C3	C4
A1	B1	2348.63	2018.09	1851.15	2053.14
	B2	2051.21	1747.70	1600.42	1761.89
	B3	2210.47	1831.61	1657.54	1814.04
A2	B1	1980.48	1755.71	1677.60	1862.57
	B2	1853.75	1622.80	1508.91	1672.53
	B3	2027.03	1708.82	1558.91	1712.95
A3	B1	1685.48	1551.91	1467.36	1650.37
	B2	1554.16	1398.94	1327.86	1494.15
	B3	1639.05	1465.58	1369.51	1516.35

The data obtained in the research prove that the highest productivity of pumpkin is achieved provided that the inter-row spacing is 140 cm being 15.5–25.2 t/ha in the variety Yanina, 17.3–26.7 t/ha in the variety Dolia, 21.0–30.3 t/ha in the variety Rodzynka on average for three years depending on the dose of fertilizers.

When sown with the inter-row spacing of 70 cm the fruit productivity fell by 2.1–3.9 t/ha in the variety Yanina, by 1.2–3.0 t/ha in the variety Dolia and by 1.8–3.2 t/ha in the variety Rodzynka, and with the inter-row spacing of 210 cm – by 0.8–1.2, 0.7–1.6 and 0.5–1.3 t/ha respectively.

The application of mineral fertilizers at the dose of $N_{60}P_{60}$ contributed to an increase in the fruit productivity of pumpkin, when compared to the variant without fertilizers: by 51–59% in the variety Yanina, by 40–55% in the variety Dolia, and by 36–42% in the variety Rodzynka on average for three years. A decrease in the dose of fertilizers to $N_{30}P_{30}$ caused a decline in the fruit productivity of pumpkin by 18–20, 13–17 an 14–16% respectively.

Table 5. Impact of the factors under study on the level of profitability of pumpkin production, % (the average in 2017-2019)

Variety (A)	Inter-row spacing, cm (B)	Dose of fertilizers (C)			
		C1	C2	C3	C4
A1	B1	70.3	98.2	116.1	94.8
	B2	95.0	128.9	149.9	127.0
	B3	81.0	118.4	141.3	120.5
A2	B1	102.0	127.8	138.4	114.8
	B2	115.8	146.5	165.1	139.2
	B3	97.3	134.1	156.6	133.5
A3	B1	137.3	157.7	172.6	142.4
	B2	157.4	185.9	201.2	167.7
	B3	144.0	172.9	192.1	163.8

It is necessary to mention that an increase in the dose of fertilizers from $N_{60}P_{60}$ to $N_{90}P_{90}$ caused an inconsiderable rise in the yield at the level of 20.2–23.7 and 21.3–25.2 in the variety Yanina, 22.5–25.3 and 23.7–26.7 in the variety Dolia, 26.1–29.2 and 27.1–30.3 t/ha in the variety Rodzynka respectively.

In order to implement any element of the growing technology efficiently it is necessary to perform economic evaluation which will allow determining the appropriateness of using it. The main indexes of economic evaluation are the cost price of an item, net profit and the level of profitability (Hryzenkova et al., 1996).

In our experiments the maximal economic efficiency of pumpkin fruit production was reached when growing the varieties Dolia and Rodzynka and applying $N_{60}P_{60}$ in basic tillage and the inter-row spacing of 140 cm, that provided the cost price of 1508.91 and 1327.86 UAH/t respectively (Table 3), the net profit of 63024 and 78026 UAH/ha (Table 4), and the level of profitability of 165.1 and 201.2% (Table 5).

Table 4. The net profit of growing pumpkin fruits depending on the factors under study, UAH/ha (the average in 2017-2019)

Variety (A)	Inter-row spacing, cm (B)	Dose of fertilizers (C)			
		C1	C2	C3	C4
A1	B1	22128.31	33890.73	43406.77	41468.11
	B2	30206.25	45045.97	56869.99	56400.37
	B3	25590.29	41199.33	53408.02	53337.34
A2	B1	32514.23	44661.30	52254.03	50657.19
	B2	37130.19	51585.25	63024.61	62143.55
	B3	30975.57	46969.28	59562.63	59463.40
A3	B1	44438.80	55816.54	66101.91	63675.07
	B2	51362.74	66587.12	78026.48	75927.18
	B3	46746.78	61586.50	74179,85	74012.79

Conclusions

In order to obtain fruit yields of 25–30 t/ha when growing pumpkin under conditions of the South of Ukraine we recommend planting the highly productive varieties Dolia and Rodzynka with the inter-row spacing of 140 cm and applying $N_{60}P_{60}$, that ensures the net profit of 63024 and 78026 UAH/ha and the level of profitability of 165.1 and 201.2% respectively.

References

Agu, C. (2004). Growth and yield responses of pumpkin (*Cucurbita maxima*) to poultry manure applications and staking techniques in Southeastern Nigeria. *Journal of Sustainable Agriculture*, *24(2),* 5-10.

Aktaş, N., Gerçekaslan, K. E. & Uzlaşlr, T. (2018). The effect of some pre-roasting treatments on quality characteristics of pumpkin seed oil. *OCL – Oilseeds and fats, Crops and Lipids*, *25(3),* 2018025.

Almrani, H. A., Abdel-rasool, I. J. & Muhammad, S. A. (2016). Effect of organic fertilizers and magnetized water in growth and yield of medical pumpkin from fixed oil and its components. *Iraqi Journal of Agricultural Sciences*, *47(1),* 271-282.

Assous, M. T. M., Saad, E. M. S. & Dyab, A. S. (2014). Enhancement of quality attributes of canned pumpkin and pineapple. *Annals of Agricultural Sciences*, *59(1),* 9-15.

Bai, Y., Zhang, M., Chandra Atluri, S., Chen, J. & Gilbert, R. (2020). Relations between digestibility and structures of pumpkin starches and pectins. *Food Hydrocolloids*, *106,* 105894.

Belik, V. F. (1982). Melon production. Moscow, Kolos, 150-175 (Ru).

Chu, C. C., Hasan, Z. A. B. A., Chua, S. K. & Nyam, K. L. (2020). Formulation and characterization of novel nanostructured lipid carriers with photoprotective properties made from carnauba wax, beeswax, pumpkin seed oil, and UV filters. *JAOCS, Journal of the American Oil Chemists' Society*, *97(5),* 531-542.

Ekanem, N. G. & Akpheokhai, L. I. (2019). Neem leaf and poultry manures soil amendment on growth and yield of *Telfairia occidentalis*. *Eurasian Journal of Soil Science*, *8(4),* 313-320.

Hryzenkova, Z. I., Honcharov, O. M. & Levina, R. V. (1996). Energetic evaluation of vegetable production costs. *Vegetable Growing and Melon Production*, *41,* 9-13 (Ua).

Juknevičienė, E., Danilčenko, H., Jarienė, E. & Fritz, J. (2019). The effect of horn-manure preparation on enzymes activity and nutrient contents in soil as well as great pumpkin yield. *Open Agriculture*, *4(1),* 452-459.

Kiendler, A. (1997). The (Styrian) Olkurbis Fortchr. *Farmer, 8,* 12-13.

Knysh, V. (2018). Bare-seeded pumpkin. *Plantator*, *2,* 112-114 (Ua).

Koltunov, V., Bulakh, M. & Orlov, D. (2016a). Basics of pumpkin yield formation. *Plantator*, *3 (27),* 68-71 (Ua).

Koltunov, V., Bulakh, M. & Orlov, D. (2016b). The yield structure of pumpkin depending on a variety. *Plantator*, *4 (28),* 78-80 (Ua).

Ladychuk, D., Shaporynska, N., Lavrenko, S. & Lavrenko, N. (2021). The methods for determining agrolandscape typicality for projects of water supply construction. *AgroLife Scientific Journal, 10 (1),* 121-129.

Lalnunthari, C., Devi, L. M. & Badwaik, L. S. (2020). Extraction of protein and pectin from pumpkin industry by-products and their utilization for developing edible film. *Journal of Food Science and Technology*, *57(5),* 1807-1816.

Lavrenko, S. O., Lavrenko, N. M., Maksymov, D. O., Maksymov, M. V., Didenko, N. O. & Islam, K. R. (2021). Variable tillage depth and chemical fertilization impact on irrigated common beans and soil physical properties. *Soil and Tillage Research, 212,* 105024.

Lawal, A. B., Aissami, B. M. & Lawal, H. M. (2009). Influence of mineral fertilizer on productivity and growth of four varieties of squash pumpkin (*Cucurbita maxima* L.). *Advances in Horticultural Science*, *23(3),* 201-204.

Loy, J. B. (2004). Morpho-physiological aspects of productivity and quality in squash and pumpkins (*Cucurbita* spp.). *Critical Reviews in Plant Sciences*, *23(4),* 337-363.

Lykhatskyi, V. I. (2002). Melon production. Kyiv, Higher School, 79-84 (Ua).

Maidaniuk, V. (2012). Patty pan squash. *Vegetable Growing*, *12 (96),* 50-55 (Ru).

Maidaniuk, V. (2016). Pumpkin as an oilseed crop. *Vegetable Growing*, *1 (131),* 22-25 (Ru).

Mehditabar, H., Razavi, S. M. A. & Javidi, F. (2020). Influence of pumpkin puree and guar gum on the bioactive, rheological, thermal and sensory properties of ice cream. *International Journal of Dairy Technology*, *73(2),* 447-458.

Momirović, N., Oljača, S., Dolijanović, Ž., Simić, M., Oljača, M. & Janošević, B. (2015). Productivity of intercropping maize (*Zea mays* L.) and pumpkins (*Cucurbita maxima* Duch.) under conventional vs. conservation farming system. *Turkish Journal of Field Crops*, *20(1*), 92-98.

Oloyede, F. M. (2012). Growth, yield and antioxidant profile of pumpkin (*Cucurbita pepo* L.) leafy vegetable as affected by NPK compound fertilizer. *Journal of Soil Science and Plant Nutrition*, *12(3),* 379-387.

Oloyede, F. M., Agbaje, G. O., Obuotor, E. M. & Obisesan, I. O. (2012). Nutritional and antioxidant profiles of pumpkin (*Cucurbita pepo* Linn.) immature and mature fruits as influenced by NPK fertilizer. *Food Chemistry*, *135(2),* 460-463.

Quijano-Ortega, N., Fuenmayor, C.A., Zuluaga-Dominguez, C., Diaz-Moreno, C., Ortiz-Grisales, S., García-Mahecha, M. & Grassi, S. (2020). FTIR-ATR spectroscopy combined with multivariate regression modeling as a preliminary approach for carotenoids determination in *Cucurbita* spp. *Applied Sciences (Switzerland)*, *10(11),* 3722.

Rohman, A. & Irnawati (2020). Pumpkin (*Cucurbita maxima*) seed oil: Chemical composition, antioxidant activities and its authentication analysis. *Food Research*, *4(3),* 578-584.

Rouag, M., Berrouague, S., Djaber, N., Khaldi, T., Boumendjel, M., Taibi, F., Abdennour, C., Boumendjel, A. & Messarah, M. (2020). Pumpkin seed oil alleviates oxidative stress and liver damage induced by sodium nitrate in adult rats: Biochemical and histological approach. *African Health Sciences*, *20(1),* 413-425.

Serhienko, O. (2017). Pumpkin for seeds. *The Proposal*, *11,* 84-89 (Ua).

Studstill, D. W., Simonne, E. H., Hutchinson, C. M., Hochmuth, R. C., Dukes, M. D. & Davis, W. E. (2003). Petiole sap testing sampling procedures for monitoring pumpkin nutritional status. *Communications in Soil Science and Plant Analysis*, *34(15-16),* 2355-2362.

Sych, Z. (2016). Lessons in pumpkin production. *The Gardener*, *4,* 6-7 (Ru).

Yevtushenko, O. T. & Romanov, P. S. (2018). Topical trends in research on improving agro-ecological technology of muscat pumpkin production. In: *Ecological problems of the environment and efficient nature management in the context of sustainable development*. Proceedings of International scientific-practical conference, Kherson, 114-118 (Ua).

Zhao, J., Liu, W., Chen, D., Song, Y., Zhang, Y., Ni, Y. & Li, Q. (2015). Physico-chemical and antioxidant properties of different pumpkin cultivars grown in China. *Advance Journal of Food Science and Technology*, *9(4),* 308-316.

Received: May 6, 2021; *Accepted:* August 31, 2021; *Published:* February, 2022