

## Cluster analysis of morphological traits in cucumber hybrid varieties (Ukrainian Right-Bank Forest-Steppe area)

Z. D. Sych<sup>1</sup>, S. M. Kubrak<sup>1\*</sup>, K. I. Velyka<sup>2</sup>, V. I. Hlevaskyi<sup>1</sup>, I. M. Sydorova<sup>1</sup>,  
L. A. Shubenko<sup>1</sup>

<sup>1</sup>Department of Genetics, Breeding and Seed Production, Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine

<sup>2</sup>Department of Foreign Languages, Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine  
Corresponding author E-mail: kubraksweeta@ukr.net

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The influence of weather conditions on vegetable crops plays an important role in the cucumber production. The biggest amount of cultivated fields is situated in the areas that are under risk for agriculture. Our research aim is to study different cucumber heterozygous hybrid varieties. Their chemical composition, crop formation, growing season, stem thickness near the root collar, main stem length, leaf area, leaf number per plant are of great importance to form clusters, the samples of which could give the highest cucumber productivity under Ukraine Right-Bank Forest-Steppe conditions. The samples of 36 cucumber heterozygous hybrid varieties of Ukrainian and foreign breeding (Russian, Italian, French) have been studied at Bila Tserkva National Agrarian University Training and Production Center. The variety estimation of 36 heterozygous samples shows that they have 17 traits. It has allowed us to subdivide them into five clusters at the lowest level under Ukraine Right-Bank Forest-Steppe conditions. In the plant nursery, all cucumber varieties are presented by six the most common hybrid samples. There are three samples that have been bred in Ukraine (Suvenir F1, Lyaluk F1, Vodogray F1), 1 in Poland (Sremski F1) and 2 in The Netherlands (Masha F1, Crispina F1).

**Keywords:** Cucumber; Heterozygous hybrid; Yield; Growing season; Dry soluble substance

### Introduction

A cucumber (*Cucumis sativus* L.) is the most popular vegetable crop in the world (Abbasi et al., 2020; Sarwar et al., 2017; Priyanka et al., 2016). It's the third cultivated vegetable crop in Ukraine (10 – 14%) and about 120 thousand hectares are occupied by this culture. The cucumber production is considered to be profitable, highly efficient and low-cost for Ukrainian olericulture and melon growing (Galat, 2019). However, there is an acute shortage of the cucumber production (State Statistics Service of Ukraine, 2017). According to the market requirements and the conditions of the particular farms, there is a problem of poor crop yields caused by wrong breeding. In the total amount of the domestic market, 22% of cucumbers belong to the Ukrainian breeding, about 40% – to Dutch breeding, 13% – to German and the rest – to other countries. (Me'lnik, 2017; Mel'nik, 2018). The cucumber biological potential in the open ground does not always reveal in Kiev region. As a result of unfavorable weather conditions there is a possibility to get poor crop yields (Sych, 2018). Thus, the problem of the best heterozygous hybrid breeding requires a constant study of the growing season, the fruiting period, the plant biometric indices, the yielding capacity, the fruit biochemical composition. Our research aim was to consider the cucumber trait variability in order to select the most productive hybrid samples by cluster analysis.

### Materials and Methods

According to the requirements of the determined methods, the research has been conducted in the experimental field of Bila Tserkva National Agrarian University Training and Production Center (Dosphehov, 1985; Bondarenko&Jakovenko, 200). The hybrids of Vodogray F1 have been used as a control group 1 (early-ripening varieties) and the hybrids of Samorodok F1 – as a control group 2 (medium-ripening varieties). In 2018, 2019, cucumbers were grown by the seedlingless method in the field. The plant density was about 60 thousand plants per ha. Test samples consisted of 36 cucumber heterozygous hybrids (Ukrainian, Russian, Italian, and French breeding). The obtained data have been evaluated by using multi-dimensional statistical and cluster analysis (Sych, 1993). That's why the heterozygous hybrids have been described in accordance to 17 traits:

- 1) The period from germination to the commercial maturity of the 1st fruit (days);
- 2) The duration of the fruiting period (days);
- 3) The thickness of the stem near the root collar (mm);
- 4) The length of the main shoot (m);
- 5) The number of leaves per plant (amount);
- 6) The area of the 11th and 12th leaf (cm<sup>2</sup>);
- 7) The yield amount for the first 10 days (t/ha);
- 8) The early harvest amount (%);
- 9) The yield capacity (t/ ha);
- 10) The amount of marketable fruits in the total yield (%);

- 11 – 12) The amount of gherkins and picklers in the commodity part of the harvest (%);  
 13) The non-commodity part of the harvest (%);  
 14) The amount of dry soluble substances (%);  
 15) The amount of total sugars (%);  
 16) The amount of ascorbic acid (mg/100 g);  
 17) The amount of nitrates (mg/kg).

During the experimental period, there was the highest amount of rainfall (230 mm) in 2018, but there was the lowest amount of rainfall (164.8 mm) in 2019. The average annual air temperature varied from +15.9°C to + 23.6°C. The highest total amount of active temperatures was noticed during the growing season (220.8°C) in 2018, and the lowest – (222°C) in 2019. In general, the weather conditions were favorable for cucumber growing.

## Results

A period from germination to maturity of the 1<sup>st</sup> fruit depends on the temperature, rainfall and elements of the cultivation technology (Table 1). All cucumber hybrids, selected as test samples, have been divided according to the growing season into two groups: early ripening (38 – 45 days) and medium ripening (51 – 53 days) varieties.

The most early ripening variety hybrids are Satin F<sub>1</sub> (38 days), Masha F<sub>1</sub> (40 days), Moringa F<sub>1</sub> (39 days), Harmonie F<sub>1</sub> (40 days) and Cupid F<sub>1</sub> (39 days). The fruiting period of these samples starts 2 – 4 days earlier than in the control group (Vodogray F<sub>1</sub> – 42 days).

**Table 1.** Cucumber hybrid interphase periods (the average indices in 2018, 2019).

Hybrid	Days from germination to commercial maturity of the first fruit	Fruiting days
<b>Early ripening hybrids</b>		
Vodogray F <sub>1</sub> (The control group 1)	42	42
Relay F <sub>1</sub>	41	45
Casper F <sub>1</sub>	43	42
Chrobry F <sub>1</sub>	42	38
Atlantis F <sub>1</sub>	43	45
Natasha F <sub>1</sub>	44	48
Cupid F <sub>1</sub>	39	40
Julian F <sub>1</sub>	45	40
Sigurd F <sub>1</sub>	44	43
Anulka F <sub>1</sub>	45	46
Harmonie F <sub>1</sub>	40	38
Accord F <sub>1</sub>	45	32
Alex F <sub>1</sub>	42	38
Sremski F <sub>1</sub>	43	42
Ajax F <sub>1</sub>	42	47
Moringa F <sub>1</sub>	39	37
Regia F <sub>1</sub>	45	44
Krak F <sub>1</sub>	42	39
Crispina F <sub>1</sub>	43	34
Masha F <sub>1</sub>	40	32
Regal F <sub>1</sub>	44	36
Asterix F <sub>1</sub>	45	43
Octopus F <sub>1</sub>	45	43
Satina F <sub>1</sub>	38	30
Patriot F <sub>1</sub>	44	35
Sonata F <sub>1</sub>	42	36
<b>Medium ripening hybrids</b>		
Samorodok F <sub>1</sub> (The control group 2)	53	51
Smak F <sub>1</sub>	51	45

Xana F <sub>1</sub>	52	48
Starex F <sub>1</sub>	53	50
Estafeta F <sub>1</sub>	55	48
Andrus F <sub>1</sub>	51	53
Sander F <sub>1</sub>	54	53
Suvenir F <sub>1</sub>	52	55
Sremianin F <sub>1</sub>	55	45
Lyaluk F <sub>1</sub>	53	42

Among early ripening hybrid varieties, the longest growing season is inherent in such samples as: Julian F<sub>1</sub>, Anulka F<sub>1</sub>, Accord F<sub>1</sub>, Regia F<sub>1</sub>, Asterix F<sub>1</sub>, Octopus F<sub>1</sub>. The first fruits have been harvested in 45 days after germination, which is 3 days later than in the control group 1 (Vodogray F<sub>1</sub>). The cucumber fruits of Relay F<sub>1</sub>, Casper F<sub>1</sub>, Chrobry F<sub>1</sub>, Atlantis F<sub>1</sub>, Alex F<sub>1</sub>, Sremski F<sub>1</sub>, Ajax F<sub>1</sub>, Krak F<sub>1</sub>, Crispina F<sub>1</sub>, Sonata F<sub>1</sub> have been gathered almost simultaneously with the control group ( $\pm 1$  day).

The medium-ripening hybrid group consists of 10 samples: Samorodok F<sub>1</sub> (the control group 2), Smak F<sub>1</sub>, Xana F<sub>1</sub>, Starex F<sub>1</sub>, Relay F<sub>1</sub>, Andrus F<sub>1</sub>, Sander F<sub>1</sub>, Suvenir F<sub>1</sub>, Sremianin F<sub>1</sub> and Lyaluk F<sub>1</sub>.

Such hybrids as Smak F<sub>1</sub> (51 days), Xana F<sub>1</sub> (52 days), Andrus F<sub>1</sub> (51 days), Suvenir F<sub>1</sub> (52 days) give fruits 1 – 2 days earlier than the control group. Simultaneously with the control group 2 (Samorodok F<sub>1</sub>), the samples of Starex F<sub>1</sub> and Lyaluk F<sub>1</sub> have been gathered on the 53<sup>rd</sup> day after germination. The first fruit formation of Sander F<sub>1</sub> (54 days) and Sremianin F<sub>1</sub> (55 days) starts later.

The fruiting period of the early-ripening hybrid ranges from 30 to 48 days. Some hybrids have the shortest fruiting period that is even shorter than in the control group 1 (Vodogray F<sub>1</sub>). Among them are the following: Chrobry F<sub>1</sub> (38 days), Cupid F<sub>1</sub> (40 days), Julian F<sub>1</sub> (40 days), Accord F<sub>1</sub> (32 days), Harmonie F<sub>1</sub> (38 days), Alex F<sub>1</sub> (38 days), Moringa F<sub>1</sub> (37 days), Krak F<sub>1</sub> (39 days), Crispina F<sub>1</sub> (34 days), Masha F<sub>1</sub> (32 days), Regal F<sub>1</sub> (36 days), Satina F<sub>1</sub> (30 days), Patriot F<sub>1</sub> (35 days), Sonata (36 days).

Some varieties have the longest fruiting period: Atlantis F<sub>1</sub> (45 days), Natasha F<sub>1</sub> (48 days), Anulka F<sub>1</sub> (46 days), Ajax F<sub>1</sub> (47 days), Regia F<sub>1</sub> (44 days). The control group of Vodogray F<sub>1</sub> has almost the same fruiting period (42 days) as Casper F<sub>1</sub>, Sigurd F<sub>1</sub>, Sremski F<sub>1</sub>, Asterix F<sub>1</sub> and Octopus F<sub>1</sub>.

In the group of medium-ripening hybrids, the hybrids of Souvenir F<sub>1</sub> have the longest fruiting period (55 days) that is 4 days longer (51 days) than in the control group 2 (Samorodok F<sub>1</sub>). However, the hybrids of Andrus F<sub>1</sub> and Sander F<sub>1</sub> have 2 days longer fruiting period (53 days) than in the control group. It has been noticed that Smak F<sub>1</sub> (45 days), Xana F<sub>1</sub> (48 days), Estafeta F<sub>1</sub> (48 days), Sremianin F<sub>1</sub> (45 days), Lyaluk F<sub>1</sub> (42 days) have shorter fruiting period.

For cucumber production, it is important to get early fruits because the price is higher and it is possible to get more profit. The yield of different cucumber varieties for the first 10 fruiting days is given in the Table 2.

**Table 2.** Cucumber yield for the first 10 fruiting days.

Hybrid	Yield for the first 10 fruiting days t/ha			Early yield index
	2018	2019	Average index in 2018. 2019	
<b>Early ripening hybrids</b>				
Vodogray F <sub>1</sub> (The control group 1)				
Relay F <sub>1</sub>	5.3	5.8	5.6	12.6
Casper F <sub>1</sub>	4.8	5.5	5.2	11.8
Chebrov F <sub>1</sub>	4.5	5.3	4.9	12.5
Chrobry F <sub>1</sub>	5.0	5.3	5.2	14.0
Atlantis F <sub>1</sub>	6.0	6.2	6.1	11.7
Natasha F <sub>1</sub>	3.5	4.6	4.1	11.1
Cupid F <sub>1</sub>	5.5	6.2	5.9	12.8
Julian F <sub>1</sub>	4.1	4.5	4.3	13.1
Sigurd F <sub>1</sub>	3.8	4.6	4.2	12.2
Anulka F <sub>1</sub>	4.5	4.9	4.7	11.4
Harmonie F <sub>1</sub>	3.5	4.8	4.2	14.0
Accord F <sub>1</sub>	6.1	6.5	6.3	16.4
Alex F <sub>1</sub>	5.0	5.3	5.2	14.0
Sremski F <sub>1</sub>	5.3	5.3	5.3	11.5
Ajax F <sub>1</sub>	3.3	4.5	3.9	11.2
Moringa F <sub>1</sub>	5.6	6.2	5.9	14.2

Regia F <sub>1</sub>	4.3	5.3	4.8	12.0
Krak F <sub>1</sub>	5.2	5.4	5.3	13.5
Crispina F <sub>1</sub>	4.7	5.4	5.1	15.6
Masha F <sub>1</sub>	5.0	4.5	4.8	16.6
Regal F <sub>1</sub>	4.3	5.1	4.7	14.6
Asterix F <sub>1</sub>	3.5	3.9	3.7	12.2
Octopus F <sub>1</sub>	2.5	3.5	3.0	12.2
Satina F <sub>1</sub>	3.8	4.6	4.2	17.5
Patriot F <sub>1</sub>	4.8	5.6	5.2	15.1
Sonata F <sub>1</sub>	5.2	5.8	5.5	14.6
<b>HIP<sub>05</sub></b>			0.58	
<b>Medium ripening hybrids</b>				
Samorodok F <sub>1</sub> (The control group2)	5.3			
		5.8	5.6	10.4
Smak F <sub>1</sub>	5.7	6.3	6.0	11.7
Xana F <sub>1</sub>	6.2	6.8	6.5	11.0
Starex F <sub>1</sub>	6.4	7.0	6.7	10.5
Estafeta F <sub>1</sub>	5.5	6.1	5.8	11.0
Andrus F <sub>1</sub>	5.3	5.8	5.6	10.0
Sander F <sub>1</sub>	5.8	6.4	6.1	12.3
Suvenir F <sub>1</sub>	6.3	6.9	6.6	9.9
Sremianin F <sub>1</sub>	6.4	7.0	6.7	11.7
Lyaluk F <sub>1</sub>	5.2	5.7	5.5	12.6
<b>HIP<sub>05</sub></b>			0.08	

In 2018, the hybrids of Cupid F<sub>1</sub> (5.5 t/ha), Accord F<sub>1</sub> (6.1 t/ha), Moringa F<sub>1</sub> (5.6 t/ha) gave the biggest amount of fruits for the first 10 fruiting days, but the hybrids of Octopus F<sub>1</sub> gave the lowest yield (2.5 t/ha). Such varieties as Relay F<sub>1</sub>, Casper F<sub>1</sub>, Chrobry F<sub>1</sub>, Natasha F<sub>1</sub>, Julian F<sub>1</sub>, Sigurd F<sub>1</sub>, Anulka F<sub>1</sub>, Harmonie F<sub>1</sub>, Alex F<sub>1</sub>, Ajax F<sub>1</sub>, Regia F<sub>1</sub>, Crispina F<sub>1</sub>, Masha F<sub>1</sub>, Regal F<sub>1</sub>, Asterix F<sub>1</sub>, Satina F<sub>1</sub>, Patriot F<sub>1</sub> gave less yield than the hybrids of Vodogray (the control group 1). Their yield amount ranged from 3.3 t/ha to 5.0 t/ha for 10 fruiting days. Almost the same situation was observed in 2019. The hybrids of Cupid F<sub>1</sub>, Atlantis F<sub>1</sub> and Moringa F<sub>1</sub> had the highest fruiting index 6.2 t/ha for the first 10 days and Accord F<sub>1</sub> – 6.5 t/ha for the same period. The hybrids of Octopus F<sub>1</sub> and Asterix F<sub>1</sub> had the lowest results (3.5 and 3.9 t/ha) and it was lower by 2.3 and 1.9 t/ha in comparison with the control group 1 (Vodogray F<sub>1</sub>). The hybrids of Sonata F<sub>1</sub> had almost the same yield level (5.8 t/ha) as the control group 1 (Vodogray F<sub>1</sub>) for the first 10 fruiting days. A two year research has shown that on average, Accord F<sub>1</sub> and Atlantis F<sub>1</sub> have the highest yield of cucumber fruits (6.3 and 6.1 t/ha) for the first 10 fruiting days. However, a significant difference has been observed in this index only in the first case. The early-ripening cucumber hybrids with the highest early production index are Chrobry F<sub>1</sub> (14%), Harmonie F<sub>1</sub> (14%), Accord F<sub>1</sub> (16.4%), Alex F<sub>1</sub> (14%), Moringa F<sub>1</sub> (14.2%), Crispina F<sub>1</sub> (15.6%), Masha F<sub>1</sub> (16.6%), Regal F<sub>1</sub> (14.6%), Satina F<sub>1</sub> (17.5%), Patriot F<sub>1</sub> (15.1%), Sonata F<sub>1</sub> (15.1%). The hybrids of Natasha F<sub>1</sub> and Ajax F<sub>1</sub> are the least productive (Natasha F<sub>1</sub> – 11.1%, Ajax F<sub>1</sub> – 11.2%).

In 2018, the medium-ripening cucumber hybrids of Starex F<sub>1</sub>, Sremianin F<sub>1</sub>, Souvenir F<sub>1</sub>, Xana F<sub>1</sub> gave the highest yield for the first 10 fruiting days. They had the following results: Starex F<sub>1</sub> – 6.4 t/ha, Sremianin F<sub>1</sub> – 6.4 t/ha; Souvenir F<sub>1</sub> – 6.3 t/ha and Xana F<sub>1</sub> – 6.2 t/ha. The control group2 (Samorodok F<sub>1</sub>) gave 5.3 t/ha. Ajax F<sub>1</sub> and Starex F<sub>1</sub> had the highest yield index (7.0 t/ha) for the first 10 fruiting days in 2019. Andrus F<sub>1</sub> and Lyaluk F<sub>1</sub> had almost the same results as the control group (Andrus F<sub>1</sub> – 5.8 t/ha, and Lyaluk F<sub>1</sub> – 5.7 t/ha).

In 2018, 2019, the medium-ripening hybrids of Starex F<sub>1</sub> and Sremianin F<sub>1</sub> gave the highest yield (6.7 t/ha) for 10 fruiting days. Lyaluk F<sub>1</sub> gave 5.5 t/ha and it was the lowest result. All samples had good results except Lyaluk F<sub>1</sub> (5.5 t/ha) and Andrus F<sub>1</sub> (5.6 t/ha). The biggest amount of the early production was given by Lyaluk (12.6%) and Sander (12.3%). Souvenir F<sub>1</sub> and Andrus F<sub>1</sub> had the lowest results. Souvenir F<sub>1</sub> gave 9.9% of fruits, Andrus F<sub>1</sub> – 10%.

The marketable fruit yield and its index changes every year in the plant nursery. The results primarily depend on the sample genotype and the weather conditions (Table 3). In 2018, a high yield was given by such varieties as Atlantis F<sub>1</sub> (51.3 t/ha), Cupid F<sub>1</sub> (45.0 kg/m<sup>2</sup>) and Sremski F<sub>1</sub> (44.1 t/ha). Octopus F<sub>1</sub> and Satina F<sub>1</sub> had low results (20.4 and 21.7 t/ha) as well. It was managed to gather the yield of Relay F<sub>1</sub>, Cupid F<sub>1</sub>, Anulka F<sub>1</sub>, Sremski F<sub>1</sub>, Moringa F<sub>1</sub>, Krak F<sub>1</sub> with the same results (42.3 t/ha) as the control group 1 (Vodogray F<sub>1</sub>). In 2019, the highest yield was given by the early-ripening hybrids of Atlantis F<sub>1</sub> (53.0 t/ha), Relay F<sub>1</sub> (47.0 t/ha), Cupid F<sub>1</sub> (47.1 t/ha), Sremski F<sub>1</sub> (48.3 t/ha). The lowest result was given by such varieties as Octopus F<sub>1</sub> (26.2 t/ha) and Satina F<sub>1</sub> (28.6 t/ha). A two year study of different cucumber hybrid yield capacity has shown that hybrids of Atlantis F<sub>1</sub> have significantly higher results (52.2 t/ha.). Another samples have significantly lower results: Casper F<sub>1</sub> (39.1 t/ha), Chrobry F<sub>1</sub> (37.2 t/ha), Natasha F<sub>1</sub> (37.0 t/ha), Julian F<sub>1</sub> (32.7 t/ha), Sigurd F<sub>1</sub> 34.3 t/ha, Harmonie F<sub>1</sub> (30.0 t/ha), Accord F<sub>1</sub> (38.3 t/ha), Alex F<sub>1</sub> (37.2 t/ha), Ajax F<sub>1</sub> (34.9 t/ha), Krak F<sub>1</sub> (39.3 t/ha), Crispina F<sub>1</sub> (32.7 t/ha), Masha F<sub>1</sub> (28.9 t/ha), Regal F<sub>1</sub> (32.2 t/ha), Asterix F<sub>1</sub>

(30, 3 t/ha), Octopus F<sub>1</sub> (24.5 t/ha), Satina F<sub>1</sub> (24.0 t/ha), Patriot F<sub>1</sub> (34.6 t/ha), Sonata F<sub>1</sub> (37.7 t/ha). Lewis stability index ranges from 1 to 1.4 in the early-ripening group of cucumbers. Moreover, hybrids of Atlantis F<sub>1</sub>, Cupid F<sub>1</sub>, Krak F<sub>1</sub> and especially Harmonie F<sub>1</sub>, Ajax F<sub>1</sub>, Octopus F<sub>1</sub> have turned out to be the most adapted to the conditions of the Right-Bank Forest-Steppe. There is a big amount of marketable fruits belonging to the early-ripening hybrids in the total yield. Among these hybrids are the following: Regia F<sub>1</sub> (95%), Moringa F<sub>1</sub> (94%), Anulka F<sub>1</sub> (93%), Krak F<sub>1</sub> (93%), Crispina F<sub>1</sub> (93%), Masha F<sub>1</sub> (92%), Ajax F<sub>1</sub> (92%), Sigurd F<sub>1</sub> (92%). The least amount of marketable fruits has been given by Chrobry F<sub>1</sub> (82%).

**Table 3.** Cucumber hybrid yield in the plant nursery.

Hybrid	Yield t/ha		Average index in 2018. 2019	Lewis stability index	Marketable fruit amount in the total yield%
	2018 p.	2019 p.			
ripening hybrids					
Vodogray F <sub>1</sub> (the control group 1)					87
Relay F <sub>1</sub>	42.3	46.3	44.3	1.1	85
Casper F <sub>1</sub>	41.0	47.0	44.0	1.1	85
Caspar F <sub>1</sub>	35.9	42.3	39.1	1.2	85
Chrobry F <sub>1</sub>	36.1	38.3	37.2	1.1	82
Atlantis F <sub>1</sub>	36.1	38.3	37.2	1.1	82
Atlantis F <sub>1</sub>	51.3	53.0	52.2	1.0	83
Natasha F <sub>1</sub>	31.9	42.0	37.0	1.3	85
Cupid F <sub>1</sub>	45.0	47.1	46.1	1.0	87
Julian F <sub>1</sub>	31.2	34.2	32.7	1.1	89
Sigurd F <sub>1</sub>	31.0	37.6	34.3	1.2	92
Anulka F <sub>1</sub>	39.3	42.8	41.1	1.1	93
Harmonie F <sub>1</sub>	25.3	34.7	30.0	1.4	84
Accord F <sub>1</sub>	37.1	39.5	38.3	1.1	87
Alex F <sub>1</sub>	36.1	38.3	37.2	1.1	83
Sremski F <sub>1</sub>	44.1	48.3	46.2	1.1	90
Ajax F <sub>1</sub>	29.5	40.2	34.9	1.4	92
Moringa F <sub>1</sub>	39.4	43.6	41.5	1.1	94
Regia F <sub>1</sub>	35.9	44.3	40.1	1.2	95
Krak F <sub>1</sub>	38.5	40.0	39.3	1.0	93
Crispina F <sub>1</sub>	30.4	34.9	32.7	1.1	93
Masha F <sub>1</sub>	30.4	27.4	28.9	1.1	92
Regal F <sub>1</sub>	29.4	34.9	32.2	1.2	90
Asterix F <sub>1</sub>	28.6	31.9	30.3	1.1	87
Octopus F <sub>1</sub>	20.4	28.6	24.5	1.4	88
Satina F <sub>1</sub>	21.7	26.2	24.0	1.2	89
Patriot F <sub>1</sub>	31.9	37.2	34.6	1.2	87
Sonata F <sub>1</sub>	35.6	39.7	37.7	1.1	90
<b>HIP<sub>05</sub></b>			4.5		
Medium ripening hybrids					
Samorodok F <sub>1</sub> (the control group 2)	51.4	56.2	53.8	1.1	88
Smak F <sub>1</sub>	48.7	53.9	51.3	1.1	83
Xana F <sub>1</sub>	56.5	62.0	59.3	1.1	86
Starex F <sub>1</sub>	60.8	66.5	63.7	1.1	85
Estafeta F <sub>1</sub>	50.2	55.6	52.9	1.1	85

Andrus F <sub>1</sub>	53.4	58.4	55.9	1.1	84
Sander F <sub>1</sub>	45.0	54.3	49.7	1.2	83
Suvenir F <sub>1</sub>	65.8	68.2	67.0	1.0	83
Sremianin F <sub>1</sub>	54.7	59.9	57.3	1.1	84
Lyaluk F <sub>1</sub>	41.5	45.5	43.5	1.1	84
<b>HIP<sub>05</sub></b>			2.75		

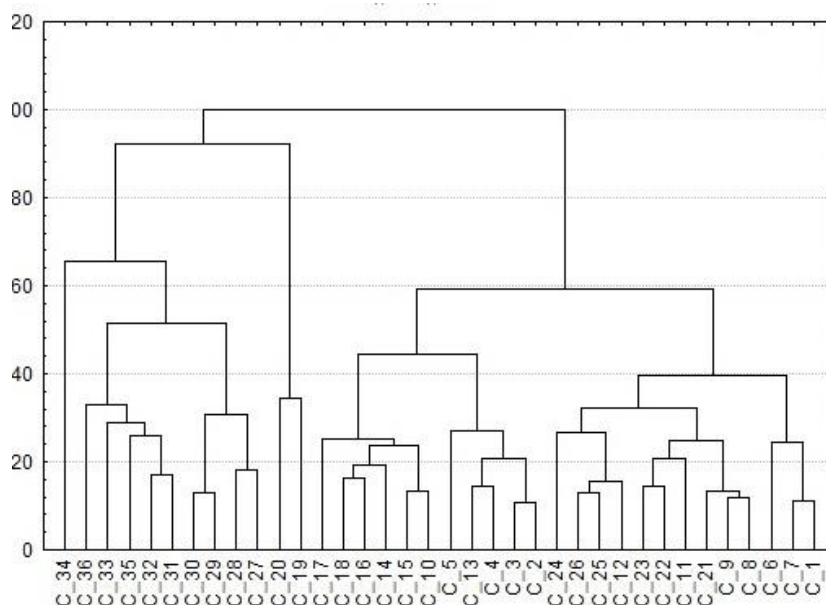
In the medium ripening hybrid group the samples of Starex F<sub>1</sub> gave better yield results (60.8 t/ha in 2018 and 66.5 t/ha) in 2019. The hybrids of Suvenir F<sub>1</sub> had the highest yield (65.8 t/ha in 2018 and 68.2 t/ha) in 2019. The hybrids of Lyaluk F<sub>1</sub> gave the worst results (41.5, t/ha in 2018 and 45.5 t/ha) in 2019.

For the experimental period, the hybrids of Starex F<sub>1</sub>, Suvenir F<sub>1</sub>, Xana F<sub>1</sub>, Sremianin F<sub>1</sub> have been noticed to have a bigger amount of cucumber fruits by 9.9; 13.2; 5.5 and 3.5 t/ha than the control group 2 (Samorodok F<sub>1</sub>).

The adaptation peculiarities of the medium ripening hybrid plants are of great importance for the high yield production. The change of Lewis stability index is seen well in the Table 3. The hybrids of Suvenir F<sub>1</sub> are adapted better (1) to Ukraine Right-bank Forest-Steppe, but the hybrids of Sander F<sub>1</sub> are adapted worse (1.2.), all other hybrids have 1.1 of Lewis stability index.

All 36 cucumber hybrid variety samples have been studied according to 17 traits and they have been grouped in one big cluster that ranges from 0 to 100 Euclidean units (EU). Moreover, this index was 100 EU in 2018 and 62 EU – in 2019. The index difference depends on the weather conditions that have not been favorable for recent years (there is less rainfall) (Figure 1).

### Connections between distances



**Figure 1.** Euclidean distances between cucumber hybrids of different clusters (on average in 2018, 2019).

C\_1 – Vodogray F<sub>1</sub> (the control group 1); C\_2 – Relay F<sub>1</sub>; C\_3 – Casper F<sub>1</sub>; C\_4 – Chrobry F<sub>1</sub>; C\_5 – Atlantis F<sub>1</sub>; C\_6 – Natasha F<sub>1</sub>; C\_7 – Cupid F<sub>1</sub>; C\_8 – Julian F<sub>1</sub>; C\_9 – Sigurd F<sub>1</sub>; C\_10 – Anulka F<sub>1</sub>; C\_11 – Harmonie F<sub>1</sub>; C\_12 – Accord F<sub>1</sub>; C\_13 – Alex F<sub>1</sub>; C\_14 – Sremski F<sub>1</sub>; C\_15 – Ajax F<sub>1</sub>; C\_16 – Moringa F<sub>1</sub>; C\_17 – Regia F<sub>1</sub>; C\_18 – Krak F<sub>1</sub>; C\_19 – Crispina F<sub>1</sub>; C\_20 – Masha F<sub>1</sub>; C\_21 – Regal F<sub>1</sub>; C\_22 – Asterix F<sub>1</sub>; C\_23 – Octopus F<sub>1</sub>; C\_24 – Satina F<sub>1</sub>; C\_25 – Patriot F<sub>1</sub>; C\_26 – Sonata F<sub>1</sub>; C\_27 – Samorodok F<sub>1</sub> (the control group 2); C\_28 – Smak F<sub>1</sub>; C\_29 – Xana F<sub>1</sub>; C\_30 – Starex F<sub>1</sub>; C\_31 – Estafeta F<sub>1</sub>; C\_32 – Andrus F<sub>1</sub>; C\_33 – Sander F<sub>1</sub>; C\_34 – Suvenir F<sub>1</sub>; C\_35 – Sremianin F<sub>1</sub>; C\_36 – Lyaluk F<sub>1</sub>.

All hybrid varieties can be divided into three groups: close (from 0 to 30 EU), medium-distant (30 EU) and distant (over 30 EU). Due to the fact that at a high distant level the number of clusters decreases very rapidly and a variety classification index is not of great importance. The analysis has been conducted at the lowest level. The hybrids of Suvenir F<sub>1</sub> (P.34) have formed the first cluster that is the most distant from others. This variety has been bred at the Institute of Vegetable and Melon growing of the National Academy of Agrarian Sciences of Ukraine. It belongs to the medium-ripening group (52 days). It is characterized by a long fruiting period (55 days). In addition, it has a high yield capacity of 67.0 t/ha. This hybrid is the most suitable for growing under Ukraine Right-Bank Forest-Steppe conditions. Its stability index is one.

The heterozygous hybrids of Lyaluk F<sub>1</sub> (C.36), Sander F<sub>1</sub> (C.33), Sremianin F<sub>1</sub> (C.35), Andrus F<sub>1</sub>, (C.32), Estafeta F<sub>1</sub> (C.31), Starex F<sub>1</sub> (C.30), Xana F<sub>1</sub> (C.29); Smak F<sub>1</sub> (C.28) and Samorodok F<sub>1</sub> (C.27) (the control group 2) have formed the 2<sup>nd</sup> cluster. All of them belong to the medium-ripening hybrids (the period from germination to the first fruit formation is 51 – 55 days). They have been bred by breeders of Ukraine, Poland and Turkey. These hybrids are similar in morphological traits. They have almost the same stem diameter near the neck of the root (1.4 cm – 1.3 cm, except Estafeta F<sub>1</sub> (P.31) and Sander F<sub>1</sub> (P.33) 1.5 cm), the number of leaves per plant (33, except for Lyalyuk F<sub>1</sub> (P.36) 35, Sremianin F<sub>1</sub> (P.35) 34 and a control group 2 (Samorodok F<sub>1</sub> (P.27)) 32), the leaf area (83 – 89 cm<sup>2</sup>). The yield of this group ranges from 43.5 t/ha to 63.7 t/ha (Lalyuk F<sub>1</sub> (P.36) and Starex F<sub>1</sub> (P.30)).

All samples, belonging to the second cluster, have similar traits. To some extent, they resemble. The standard has been established and it can present these traits.

The hybrids of Lyalyuk F<sub>1</sub> (P.36) indicate the smallest sum of Euclidean distances between samples. This variety has been bred at the Institute of Vegetable and Melon growing of the National Academy of Agrarian Sciences of Ukraine. According to the maturity group, it belongs to the medium-ripening varieties. After the shoot germination, it becomes mature in 53 days. On average, its fruiting period lasts for 42 days. The length of the main shoot reaches 1.54 m that excels almost all other samples of this cluster. The biometric index shows that the plant of this variety has a strong thickened stem (14 mm), good foliage, large leaves. The amount of early yield is 5.5 t/ha (12.6%). In 2018, 2019, the average yield was 43.5 t/ha.

The third cluster is small. It consists of such hybrids as Masha F<sub>1</sub> (p. 20) and Crispina F<sub>1</sub> (p. 19). They belong to the early-ripening group and have almost the same fruiting period (32 – 34 days). These hybrids have similar biometric index. The thickness of the stem near the root collar is 14 mm, the average number of leaves – 27, the leaf area – 81 cm<sup>2</sup> (Masha F<sub>1</sub>) and 80 cm<sup>2</sup> (Crispina F<sub>1</sub>). They have almost the same marketable fruit amount in the total yield. The hybrids of Crispina F<sub>1</sub> have given 93% of marketable fruits and the hybrid of Masha F<sub>1</sub> – 92%.

The 4<sup>th</sup> cluster consists of such varieties as Regia F<sub>1</sub> (C.17), Krak F<sub>1</sub> (C.18), Moringa F<sub>1</sub> (C.16), Sremski F<sub>1</sub> (C.14), Ajax F<sub>1</sub> (C.15), Anulka F<sub>1</sub> (C.10), Atlantis F<sub>1</sub> (C.5), Alex F<sub>1</sub> (C.13), Chrobry F<sub>1</sub> (C.4), Casper F<sub>1</sub> (C.3), Relay F<sub>1</sub> (C.2).

The period from germination to maturity of the first fruit ranges from 41 to 45 days, except Moringa F<sub>1</sub> ((P.16) – 39 days). All these samples belong to the group of early ripening hybrids. The amount of gherkins ranges from 3.3% (Anulka F<sub>1</sub> – P.10) to 6.0% (Atlantis F<sub>1</sub> – P.5) in the crop yield.

A common representative of Polish breeding is Sremski F<sub>1</sub> (P.14). The period from germination to the first mature fruit is 43 days, and its productivity – 42 days. The yield biometric and biochemical index of this hybrid occupies an intermediate value. The fruit yield for the first 10 fruiting days is 5.3 t/ha, and the amount of early harvest – 11.5%. The yield of this hybrid is 46.2 t/ha.

The fifth cluster has been formed by 13 hybrids: Sonata F<sub>1</sub> (P.26), Patriot F<sub>1</sub> (P.25), Satina F<sub>1</sub> (P.24), Octopus F<sub>1</sub> (P.23), Asterix F<sub>1</sub> (P.22), Regal F<sub>1</sub> (P.21), Accord F<sub>1</sub> (P.12), Harmonie F<sub>1</sub> (P.11), Sigurd F<sub>1</sub> (P.9), Julian F<sub>1</sub> (P.8), Cupid F<sub>1</sub> (P.7), Natasha F<sub>1</sub> (P.6), the control group 1 (Vodogray F<sub>1</sub> (C.1)). They all belong to the group of early ripening hybrids (the growing season varies from 38 to 45 days). The fruiting period varies between 30 (Satina F<sub>1</sub> (P.24)) and 48 (Natasha F<sub>1</sub> (P.6)) days. According to biometric index, the plants of these hybrids are well developed and densely leafy. They have a thick stem near the root collar (13 – 14 mm). The main shoot length is 1.3 m – 1.65 m and the leaf area is 69 – 78 cm<sup>2</sup>.

The best sample of the fifth cluster belongs to the control group 1 (Vodogray F<sub>1</sub> (C.1)). It has been bred at Donetsk Institute of Vegetable and Melon growing Research Station of the National Academy of Agrarian Sciences of Ukraine.

This is an early-ripening hybrid, that has a long-stem (length of the central stem – 1.4 m) and leaves of medium size (78 cm<sup>2</sup>). Its growing season and fruiting period are 42 days. In 2018, 2019, this hybrid gave 44.3 t/ha. The marketable fruit yield consisted mostly of pickles – 65%.

## Conclusion

The study of 36 heterozygous cucumber hybrids has been conducted according to 17 traits under Ukraine Right-Bank Forest-Steppe conditions. It has allowed to classify them at the lowest level and to identify five clusters. The first cluster has been formed only by one hybrid (Suvenir F<sub>1</sub>). The second cluster has been formed by such hybrids as Lyaluk F<sub>1</sub>, Sander F<sub>1</sub>, Sremski F<sub>1</sub>, Andrus F<sub>1</sub>, Relay F<sub>1</sub>, Starex F<sub>1</sub>, Xana F<sub>1</sub>, Smak F<sub>1</sub> and the control group 2 (Samorodok F<sub>1</sub>). The hybrids of Lyaluk F<sub>1</sub> are the most common for these samples. The third group has been formed by hybrids of Masha F<sub>1</sub> and Crispina F<sub>1</sub> (both are of equal worth).

The fourth cluster includes eleven samples: Regia F<sub>1</sub>, Krak F<sub>1</sub>, Moringa F<sub>1</sub>, Sremski F<sub>1</sub>, Ajax F<sub>1</sub>, Anulka F<sub>1</sub>, Atlantis F<sub>1</sub>, Alex F<sub>1</sub>, Chrobry F<sub>1</sub>, Casper F<sub>1</sub>, and Relay F<sub>1</sub>. Sremski F<sub>1</sub> is a common hybrid of Polish breeding for this cluster.

The hybrids of Sonata F<sub>1</sub>, Patriot F<sub>1</sub>, Satina F<sub>1</sub>, Octopus F<sub>1</sub>, Asterix F<sub>1</sub>, Regal F<sub>1</sub>, Accord F<sub>1</sub>, Harmonie F<sub>1</sub>, Sigurd F<sub>1</sub>, Julian F<sub>1</sub>, Cupid F<sub>1</sub>, Natasha F<sub>1</sub>, Vodogray F<sub>1</sub> (the control group 1) have formed the 5th cluster. The best sample of this cluster is considered to be Vodogray F<sub>1</sub>. Consequently, all different cucumber hybrids of the selected samples from the plant nursery are represented by 6 the most common representatives, three samples of which have been bred in Ukraine (Suvenir F<sub>1</sub>, Lyaluk F<sub>1</sub> and Vodogray F<sub>1</sub> (Control group 1)), one in Poland (Sremski F<sub>1</sub>) and two hybrids (Masha F<sub>1</sub> and Crispina F<sub>1</sub>) in the Netherlands.

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