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PHENOTYPIC DIVERSITY OF GARDEN PEAS FOR ECOLOGICAL AGRICULTURAL PRODUCTION

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Abstract

The aim of the present study was to determine the phenotypic diversity in 57 pea accessions determined by conventional CPVO descriptors. The study was conducted in the period 2019-2020 under irrigation conditions in the experimental field of the Maritsa Vegetable Crop Research Institute (MVCRI), Plovdiv, Bulgaria. Based on the analysis, the studied materials of peas do not have anthocyanin coloration; the majority of plants are medium tall with an average number of nodes up to and including the first fertile node; with green colour foliage; common leaf type; flecking stipules; white flowers and two pods per node. The pods are green, short and medium long with a medium width and the presence of a parchment; blunt shape of distal part (blunt ending); an average number of ovules from which develop an average of five light to dark green grains. Five groups of peas were differentiated according to the time of flowering according to CPVO-TQ / 007/2. The hierarchical cluster analysis was applied to identify the similarity and proximity of the garden pea accessions, and are grouped into two main clusters - A and B. The cluster B was the smallest and only genotype FR Ofe was involved in it with the highest values of the pod length and grains number per pod. Group "A" was divided into two subgroups: "A2" with genotype IZK-12, which differs in productivity expressed by the number and weight of pods and the weight of grains from a plant and subcluster "A1" with all other plant genotypes.

Keywords: *Pisum sativum* L., CPVO descriptors, organic production

INTRODUCTION

Phenotyping requires time and resources and is often given less attention than necessary, including conducting studies in several environments and with a limited number of genotypes. The accuracy of phenotypic estimates is crucial for the detection and use of existing genetic variations preserved in germplasm that can be effectively identified and used in breeding programs (Smykal et al., 2012). Many studies have been conducted on germplasm collections in Pisum to investigate the genetic diversity of traits (Smykal et al., 2012). There are still important gaps, especially in wild and locally adapted materials, that need to be addressed before these genetic resources are lost forever (Ford-Lloyd et al., 2010). With the expected increase in the frequency of climate change affecting agricultural production, the collection of adapted germplasm as well as resistant genotypes is a priority (Flavell et al., 2011).

Genetic diversity in selection is essential for its effectiveness. The more genetically distant the parental forms, the greater the potential for increased potential for heterosis and transgressions (Gixhari et al., 2014). Multivariate methods such as cluster, PC-analysis, etc. are used for the mathematical

proof of these differences. (Valkova, 2017).

The aim of the present study was to determine the phenotypic diversity in 57 genotypes of peas by conventional CPVO descriptors for the needs of ecological farming.

MATERIALS AND METHODS

The study was conducted during the period 2019–2020 in the experimental fields of the Maritsa Vegetable Crop Research Institute, Plovdiv, Bulgaria with 57 garden pea (*Pisum sativum* L.) accessions: 31 Bulgarian and 26 foreign. The experiments were laid out in a randomized complete block design with three replicates. The sowing was carried out in the 1st ten-day period of March and the plants are grown according to the technology adopted for field production of peas.

The main characteristics of the research were:

1. The time of flowering - when 30% of plants have at least one flower open according to the technical questionnaire of CPVO-TQ / 007/2 of 11/03/2010 and protocol for distinctness, uniformity and stability tests of the species Pisum sativum L. from the Agency Plant Variety testing, Approbation & Seed Control to Ministry of Agriculture, Food and Forestry, BG.

2. Characteristics in the CPVO Protocol: anthocyanin coloration, stem length, number of nodes up to and including first fertile node, foliage-colour, leaf type, stipule-flecking, maximum number of flowers per node, flower-colour of wing and shape of base of standard, pod: length, width, parchment, thickened wall, shape of distal part, colour, suture strings, number of ovules and intensity of green colour of grains. Unless otherwise indicated, all observations should be made at the second fertile node.

3. A hierarchical cluster analysis for grouping genotypes based on similarity as a measure of differences (the genetic distance) among them was performed.

RESULTS AND DISCUSSION

The genotypes were divided into five groups (points 1, 3, 5, 7 and 9) at the time of flowering according to the technical questionnaire CPVO-TQ / 007/2 of 11/03/2010, presented in a table 1.

The garden peas accessions, selected at the Maritsa Vegetable Crop Research Institute were distributed mainly in the late (IZK-L22/16af, IZK-L101i, IZK-1/17, IZK-14, IZK-9, IZK-Plovdiv, IZK-L1855/3) and very late (Bulgarian only) groups. Three genotypes fall into the very early (IZK-Zornitsa, IZK-5, IZK-6) and early (IZK-Musala, IZK-Ran 1, IZK-L224) groups and two in the middle.

In the next tables Characteristics of the variety were indicated (the number in brackets refers to the corresponding characteristic in the CPVO Protocol).

Table 1. Characteristics of technical questionnaire of CPVO-TQ / 007/2

	Characteristics	Accessions	Note
5.7(23)	**Time of flowering**		
	very early	5 бр.: IZK-Zornitza, IZK-5, IZK-6, DE-De и NL-Vis;	1
	early	8 бр.: IZK-Musala, IZK-Ran 1, IZK-L22$_4$, B4-/3, B4/34, UK Sugar dwarf, UK-Vir, IT Bra;	3
	medium	16 бр.: PL Ilu, BG Ami, EE Pin, SK Du, HU Debr, FR Lux, IZK-L22/16$_{об.}$, IZK-Deniza, UK VikFr, GB Linc, PL Du, FR Ofe, RU Izo, DE Man, FR Vend, DE Un;	5
	late	19 бр.: BG Echo$_{af}$, BG Kazino$_{af}$, IZK-L22/16$_{af}$, IZK-7-intr., IZK-L101i, RU Flora 6, IZK-9, IZK-Plovdiv, IZK-L1855/3, DE Mif, DE Di, DE Bal, IZK-1/17, IZK-14, DE Mul, RU ZePe, BG Pl K1, BG Pl K2, BG Pl K3;	7
	very late	9 бр.: IZK-L1857/3, IZK-L2/17, IZK-L3/17, IZK-11, IZK-Marsy, IZK-13, IZK-Vechernitsa, IZK-16, IZK-Mira.	9

The obtained data showed that all 57 genotypes had plants in which there was no anthocyanin coloration (Table 2-5.1 (1), and the colour of the foliage ranged from yellow-green (9 genotypes) to blue-green (15), as the most - they are very green - 33 (Table.2-5.4 (6).

Six genotypes had afila type of pea leaf, in which leaflets absented and only with tendrils were (Table 2-5.5 (8) and flecking of the stipules were absented in seven (Table 2-5.6 (19). The other representatives have a simple leaf type and varying degrees of flecking on the stipules.

According to the length of the stem, the studied accessions were divided into five groups (points): with a very short, short, medium, long and very long stem (Table 2-5.2 (4) and respectively, according to the number of nodes up to and including the first fertile node on the stem: with very few nodes (point 1), few (3 points), medium number (5 points), many (7) and too many (9) (Table 2-5.3 (5).

The number of ovules is best recorded when the pods are flat and should be observed before seed development (Table 3-5.18 (44). The results showed that 20 of the genotypes had few number of ovules, 33 were with medium number and four had a many number of ovules, ie. with good yield potential. The intensity of the green color of the immature (green) grains was varied from light for 20 of the studied materials, medium for 24 and dark for 13 accessions (Table 3-5.19 (45).

The genotypes of peas with stem fasciation absent formed the maximum number of flowers per node, as follows: one flower per node - one genotype; two flowers - 51 genotypes, three flowers - three genotypes and four and more - two (Table 4-5.8 (24)). As the studied genotypes had plants without anthocyanin coloring, the color of the wings of flowers was white (Table 4-5.9 (25) An important characteristic of flower was the shape of base of standard - strongly raised in 2 genotypes, moderately raised in 14, level in 24, moderately arched in 10 genotypes and strongly arched in 7 (Table 4-5.10 (28).

The length and width of the pods, the shape of distal part and the number pods per node are important cultivar characteristics. CPVO-TQ distributed genotypes in 5 points according the pod length. The groups with short (28) and medium length (27) were equal, two genotypes (DE Di, IZK-L101i) had long pods and genotypes with very short (1) and very long (9) were absented (Table 4-5.11 (35). 51 genotypes were of medium width of pod, 4 with narrow, 2 with wide and with very narrow and very wide were absented (Table 4-5.12 (36).

The grouping of genotypes (B4/33, B4/34, UK Sugar dwarf, PL Ilu) by the presence of a parchment in the pods (5.13 (37), a thickened wall (5.14 (38) in those of them in which there is a partial parchment and the presence of suture strings (5.17. (43) were present in the table 5. A relatively stable characteristic is the shape of the top of the pods (Table 5-5.15 (39), which is pointed and blunt. The color of the pods at technological maturity was varied from yellow - 10 genotypes, through green 40, blue - green - 7 and purple, which was missing in our materials (Table 5-5.16 (41).

The genotype had a significant influence on the variation of plant height, height to the first pod, unproductive nodes, number of pods and grain weight per plant (Vocanson and Jeuffroy, 2006; Kalapchieva and Pevicharova, 2016). The selection model of high-yielding varieties of peas showed that productivity could be increased by increasing the number of productive nodes per plant, the length of the pod, the number of pods on a node and the number of nodes to the first pod. This gives an idea of the main indicators when choosing the initial material for hybridization and optimal combination of the required qualities in a new variety (Sharma et al. 2000).

Table 2. Characteristics of technical questionnaire of CPVO-TQ / 007/2

Characteristics		Accessions	Note
5.1(1)	**Plant**:	**anthocyanin coloration**	
	absent	57 number for all tested genotypes	1
	present	0	
5.2(4)	**Stem:**	**length**	
	very short	6 number (n-r): IZK-Zornitza, IZK-6, UK-Vir, DE Man, FR Vend, DE Un;	1
	short	12 n-r: IZK-L22$_4$, EE Pin, FR Lux, BG Kazino$_{af}$, IZK-L22/16$_{af}$, IZK-Denitsa, RU Flora 6, DE Bal, FR Ofe, IT Bra, RU Izo, RU ZePe;	3
	medium	21 n-r: UK Sugar dwarf, NL-Vis, PL Ilu, BG Ami, SK Du, IZK-L22/16$_{об}$, BG Echo$_{af}$, IZK-Plovdiv, DE Mif, DE Di, GB Linc, IZK-L1/17, IZK-13, IZK-14, IZK-Vechernitsa, IZK-16, PL Du, DE Mul, IZK-Mira, BG Pl K1, BG Pl K3;	5
	long	7 n-r: IZK-Musala, HUDebr, IZK-7intr, IZK-L101i, IZK-L2/17, IZK-L3/17, BG Pl K2;	7
	very long	11 n-r: IZK-5, B4/33, B4/34, DE-De, IZK-9, IZK-L1857/3, IZK-L1855/3, UK VikFr, IZK-11, IZK-Marsy.	9
5.3(5)	**Stem: number of nodes up to and including first fertile node**		
	very few	3 n-r.: BG Ami, RU Flora 6, DE Un;	1
	few	15 n-r: IZK-Zornitza, UK Sugar dwarf, EE Pin, BG Kazino$_{af}$, IZK-Denitsa, IZK-L101i, IZK-9, DE Mif, DE Di, IZK-L2/17, IZK-L3/17, DE Bal, IZK-1/17, IZK-Vechernitsa, RU ZePe;	3
	medium	29 n-r: IZK-L22$_4$, IZK-5, B4/34, IZK-6, UK-Vir, SK Du, HU Debr, FR Lux, IZK-L22/16$_{об}$, BG Echo $_{af}$, IZK-L22/16$_{af}$, IZK-7-intr., IZK-Plovdiv, IZK-L1855/3, IZK-L1857/3, GB Linc, IZK-11, IZK-Marsy, IZK-13, IZK-14, IZK-16, PL Du, DE Mul, IZK-Mira, FR Ofe, IT Bra, RU Izo, FR Vend, BG Pl K1;	5
	many	7 n-r: B4/33, DE-De, NL-Vis, UK VikFr, DE Man, BG Pl K2, BG Pl K3;	7
	very many	3 n-r: IZK-Musala, IZK-Ran 1, PL Ilu.	9
5.4(6)	**Foliage:**	**colour**	
	yellow	9 n-r: IZK-Musala, IZK-Zornitza, B4/33, B4/34, IZK-6, SK Du, DE Mif, PU ZePe, De	1
	green	Un.	
	green	33 n-r: IZK-Ran 1, IZK-L22$_4$, IZK-5, UK Sugar dwarf, NL-Vis, UK-Vir, EE-Pin, FRLux, IZK-L22/16$_{об}$, BG Echo$_{af}$, BG Kazino$_{af}$, IZK-L22/16$_{af}$, IZK-Denitsa, IZ RUFlora 6, IZK-9, IZK-Plovdiv, IZK-L1857/3, DEDi, IZK-L1855/3, IZK-L2/17, U GBLinc, IZK-Marsy, IZK-13,IZK-16,PLDu,DEMul, FROfe,RUIzo, DEman, BG Pl K1.	2
	blue green	15 n-r: DE-De, PL Ilu, Bg Ami, IZK-7-intr, IZK-L3/17, DE Bal, IZK-1/17, IZK-11, IZK-14, IZK-Vechernitsa, IZK-Mira, IT Bra, BG Pl K2, BG Pl K3, FR Vend.	3
5.5(8)	**Leaf:**	**leaflets**	
	absent	6 n-r: BG Ami, BG Echo$_{af}$, BG Kazino$_{af}$, IZK-L22/16$_{af,}$ DE Bal, BG Pl K1;	1
	present	51 n-r: IZK-Musala, IZK-Zornitza, IZK-Ran 1, IZK-L22$_4$, IZK-5, B4/33, B4/34, IZK-6, UK Sugar dwarf, DE-De, NL-Vis, PL Ilu, UK-Vir, EE Pin, SK Du, HU Debr, FR Lux, IZK-L22/16$_{об}$, IZK-7intr., IZK-Denitsa, IZK-L101i, RUFlora 6, IZK-9, IZK-Plovdiv, IZK-L1857/3, IZK-L1855/3, DE Mif, DE Di, IZK-L2/17, IZK-L3/17, UK VikFr, GB Linc, IZK-1/17, IZK-11, IZK-Marsy, IZK-13, IZK-14, IZK-15, IZK-16, PL Du, DE Mul, IZK-Mira, FR Ofe, IT Bra, RU Izo, DE Man, RU ZePe, FR Vend, DE Un, BG Pl K2, BG Pl K3;	9
5.6	**19 Stipule: flecking**		
	absent	7 n-r: UK Sugar dwarf, BG Ami, EE Pin, FR Lux, IZK-L22/16a$_f$, IZK-L3/17, IZK-13,	1
	present	50 n-r: IZK-Musala, IZK-Zornitza, IZK-Ran 1, IZK-L22$_4$, IZK-5, B4/33, B4/34, IZK-6, DE-De, NLVis, PL Ilu, UKVir, SK u, HUDebr, IZK-7-intr., IZK-Denitsa, IZK-L101i, RU Flora 6, IZK-9, IZK-Plovdiv, IZK-L1857/3, IZK-L1855/3, DE Mif, DE Di, IZK-L2/17, UK VikFr, GB Linc, IZK-1/17, IZK-11, IZK-Marsy, IZK-14, IZK-Vechernitsa, IZK-16, PLDu, DEMul, IZK-Mira, FROfe, ITBra, RUIzo, DEMan, RUZePe, FRVend, DE Un, BG PlK2, BG PlK3, BG Echo$_{af}$, Kazino$_{af}$, IZK-L22/16$_{af}$, DE Bal, BG Pl K1;	9

Table 3. Characteristics of technical questionnaire of CPVO-TQ / 007/2

Characteristics		**Accessions**	**Note**
5.18(44) Pod: number of ovules			
	few	20 n-r: IZK-5, B4/33, NL-Vis, PL Ilu, BG Ami, EE Pin, FR Lux, IZK-L22/16$_{об}$, BG Kazino$_{af}$, IZK-L22/16$_{af}$, IZK-Plovdiv, IZK-L2/17, UK VikFr, IZK-16, FR Ofe, IT Bra, FR Vend, BG Pl K1, BG Pl K2, BG Pl K3	3
	medium	33 n-r: IZK-Musala, IZK-Zornitza, IZK-L22$_4$, B4/34, IZK-6, UK Sugar dwarf, DE-De, UK-Vir, SK Du, HU Debr, BG Echo$_{af}$, IZK-7-intr., IZK-Denitsa, RU Flora 6, IZK-9, IZK-L1857/3, IZK-L1855/3, DE Mif, DE Di, IZK-L3/17, DE Bal, GB Linc, IZK-1/17, IZK-11, IZK-Marsy, IZK-13, IZK-Vechern, PL Du, DE Mul, IZK-Mira, RU Izo, RU ZePe, DE Un;	5
	many	4 n-r: IZK-Ran 1, IZK-L101i, IZK-14, DE Man	7
5.19 (45) Immature seed: intensity of green colour			
	light	20 n-r: IZK-Zornitza, B4/33, B4/34, UK Sugar dwarf, PL Ilu, UK-Vir, EE Pin, SK Du, HU Debr, FR Lux, IZK-Denitsa, IZK-L1857/3, DE Mif, DE Di, UK VikFr, FR Ofe, RU Izo, DE Un, BG Pl K2, BG Pl K3;	3
	medium	24 n-r: IZK-Ran 1, IZK-L22$_4$, IZK-6, DE-De, BG Ami, IZK-L22/16$_{об}$, BG Echo $_{af}$, BG Kazino$_{af}$, IZK-L22/16$_{af}$, IZK-L101i, RU Flora 6, IZK-9, IZK-Plovdiv, IZK-L1855/3, IZK-L2/17, IZK-L3/17, DE Bal, GB Linc, IZK-1/17, IZK-13, PL Du, DE Man, RU ZePe, BG Pl K2;	5
	dark	13 n-r: IZK-Musala, IZK-5, NL-Vis, IZK-7-intr, IZK-11, IZK-Marsy, IZK-14, IZK-Vechernitsa, IZK-16, DE Mul, IZK-Mira, IT Bra, FR Vend.	7

The strong correlations between the plant height and the height of the first pod, the number of grains and pods per plant, the pod length and the number of grains in the pod and between productivity and grains per plant are important in choosing initial genotypes (Kosev, 2011). The characteristics: mass per 1000 seeds, number of seeds per pod and number of pods per plant have the maximum direct effect on grain yield, and branches and plant height have an indirect effect on yield through the number of fertile nodes, seeds of plant and internode length (Nawab et al., 2008)

The cluster analysis presented in Fig. 1 as a dendrogram showed a different grouping of genotypes by similarity and difference in two main groups (A and B). Group "A" was divided into two subgroups: "A2" with genotype IZK-Marcy = V40, which was characterized by maximum productivity values expressed by the number and weight of pods and weight of plant grains and subgroup "A1" with all other genotypes. It is noteworthy that IZK-Mira = V47 was located independently, albeit in subgroup "A1", which showed a difference in the good expression of the total number of nodes and grains per plant and the number of grains in one pod.

The accessions DE Di = V32 and IZK-14 = V42 were arranged in a separate subgroup in the sub-cluster “A1”, were located on one level closer to IZK-Mira = V47

The same time they were in close proximity to the others in the same sub-cluster. This indicates that in some of the characteristics they will show genetic similarity to IZK-Mira = V47, and in others they will be closer to the other accessions in the subgroup. These genotypes were very similar in terms of height of the first pod, the total number of nodes, the length of the pod and the number of grains in the pod.

Table 4. Characteristics of technical questionnaire of CPVO-TQ / 007/2

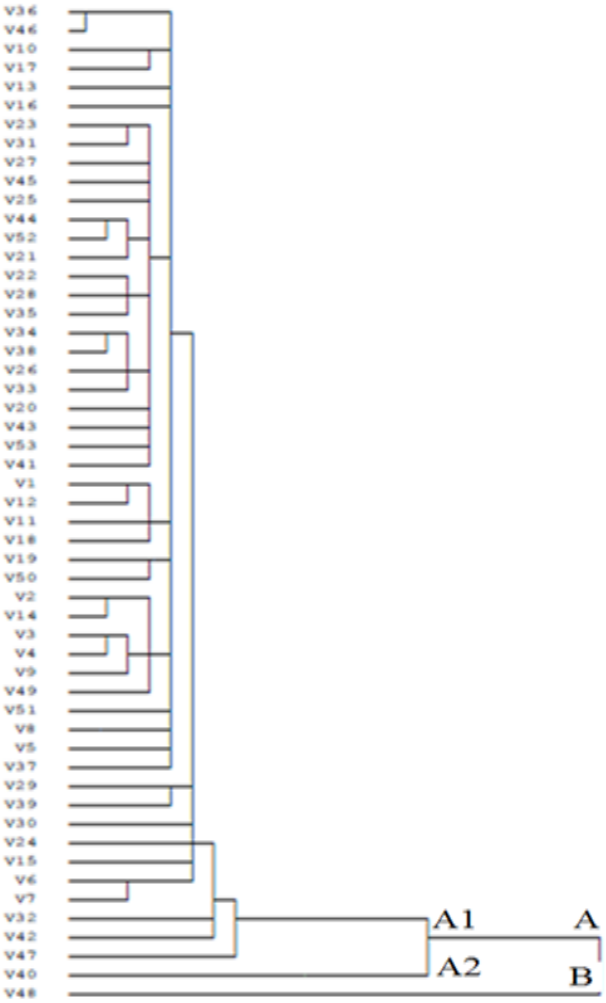
Characteristics	**Accessions**	**Note**
5.8(24) Only varieties with stem fasciation absent: Plant: maximum number of flowers per node		
one	1 n-r: IZK-Zornitza;	1
two	51 n-r: IZK-Musala, IZK-Ran 1, IZK-L22$_4$, IZK-5, B4/33, B4/34, IZK-6, UK Sugar dwarf, DE-De, NL-Vis, PL Ilu, UK-Vir, EE Pin, SK Du, HU Debr, FR Lux, IZK-L22/16$_{об}$, IZK-7-intr., IZK-Denitsa, IZK-L101i, RU Flora 6, IZK-9, IZK-Plovdiv, IZK-L1857/3, IZK-L1855/3, DE Di, UK VikFr, GB Linc, IZK-11, IZK-Marsy, IZK-13, IZK-14, IZK- Vechernitsa, IZK-16, PL Du, DE Mul, IZK-Mira, IT Bra, RU Izo, DE Man, RU ZePe, FR Vend, DE Un, BG Pl K1, BG Pl K2, BG Pl K3, BG Ami, BG Echo$_{af}$, BG Kazino $_{af}$, IZK-22/16$_{af}$, DE Bal;	3
three	3 n-r: IZK-1/17, IZK-L3/17, FR Ofe;	5
four or more	2 n-r: DE Mif, IZK-L2/17;	7
5.9(25) Only varieties with plant anthocyanin coloration present: Flower: colour of wing - absent		
5.10(28) Flower: shape of base of standard		
strongly raised	2 бр.: EE Pin, DE Di;	1
moderately raised	14 бр.: UK Sugar dwarf, Pl Ilu, HU Debr, IZK-L22/16$_{об}$, BG Echo$_{af}$, IZK-7-intr, IZK-Plovdiv, DE Mif, DE Bal, IZK-16, IT Bra, RU Izo, FR Vend, BG PL K3;	3
level	24 бр.: IZK-Ran 1, IZK-L22$_4$, B4/33, IZK-6, DE-De, NL-Vis, UK Vir, SK Du, IZK-22/16$_{af}$, IZK-Denitsa, IZK-L101i, RU Flora 6, IZK-L1857/3, IZK-L1855/3, IZK-11, IZK-Marsy, DE Mul, IZK-Mira, FR Ofe, DE Man, RU ZePe, DE Un, BG Pl K1, BG Pl K3;	5
moderately arched	10 бр.: IZK-Musala, IZK-Zornitza, B4/34, BG Ami, BG Kazino$_{af}$, IZK-9, IZK-L2/17, GB Linc, IZK- Vechernitsa, PL Du;	7
strongly arched	7 бр.: IZK-5, FR Lux, IZK-1/17, IZK-L3/17, IZK-13, IZK-14, UK VikFr.	9
5.11(35)Боб: дължина		
very short	0	1
short	27 бр.: IZK-Zornitza, B4/33, IZK-6, DE-De, NL-Vis, PL Ilu, BG Ami, EE Pin, SK Du, BG Echo$_{af}$, BG Kazino$_{af}$, IZK-7-intr, IZK-Denitsa, RU Flora 6, IZK-Plovdiv, DE Mif, IZK-L2/17, IZK-L3/17, UK VikFr, DE Bal, IZK-1/17, IZK-11, IZK- Vechernitsa, IZK-16, FR Ofe, FR Vend, BG Pl K1;	3
medium	28 бр.: IZK-Musala, IZK-Ran 1, IZK-L22$_4$, IZK-5, B4/34, UK Sugar dwarf, UK-Vir, HU Debr, FR Lux, IZK-L22/16$_{об}$, IZK-L22/16$_{af}$, IZK-9, IZK-L1857/3, IZK-L1855/3, GB Linc, IZK-12, IZK-13, IZK-14, PL Du, DE Mul, IZK-Mira, IT Bra, RU Izo, RU ZePe, DE Un, IZK-Marsy, BG Pl K2, BG Pl K3;	5
long	2 бр.: DE Di, IZK-L101i;	7
very long	0	9
5.12(36) Pod: width		
very narrow	0	1
narrow	4 бр.: RU Flora6, DE Bal, FR Ofe, DE Man;	3
medium	51 бр.: IZK-Musala, IZK-Zornitza, IZK-L22$_4$, IZK-5, B4/33, IZK-6, UK Sugar dwarf, DE-De, NL-Vis, PL Ilu, BG Ami, UK-Vir, EE Pin, SK Du, HU Debr, FR Lux, IZK-L22/16$_{об}$, BG Echo$_{af}$, BG Kazino$_{af}$, IZK-L22/16$_{af}$, IZK-7-intr., IZK-Denitsa, IZK-L101i, IZK-9, IZK-Plovdiv, IZK-L1857/3, IZK-L1855/3, DE Mif, DE Di, IZK-L2/17, IZK-L3/17, UK VikFr, GB Linc, IZK-1/17, IZK-11, IZK-Marsy, IZK-13, IZK-14, IZK-Vechernitsa, IZK-16, PL Du, DE Mul, IZK-Mira, IT Bra, RU Izo, RU ZePe, FR Vend, DE Un, BG Pl K1, BG Pl K2, BG Pl K3;	5
broad	2 бр.: IZK-Ran 1, B4/34;	7
very broad	0	9

Table 5 Characteristics of technical questionnaire of CPVO-TQ / 007/2

Characteristics		**Accessions**	**Note**
5.13(37)	**Pod:**	**parchment**	
	absent or partial	4 бр.: B4/33, B4/34, UK Sugar dwarf, PL Ilu;	1
	entire	53 бр.: IZK-Musala, IZK-Zornitza, IZK-Ran 1, IZK-L22$_4$, IZK-5, IZK-6, DE-De, NL-Vis, UK-Vir, EE Pin, SK Du, HU Debr, FR Lux, IZK-L22/16$_{об}$, IZK-7-intr., IZK-Denitsaa, IZK-L101i, RU Flora 6, IZK-9, IZK-Plovdiv, IZK-L1857/3, IZK-L1855/3, DE Di, UK VikFr, GB Linc, IZK-1/17, IZK-L2/17, IZK-L3/17, FR Ofe, IZK-11, IZK-Marsy, IZK-13, IZK-14, IZK-Vechernitsa, IZK-16, PL Du, DE Mul, IZK-Mira, IT Bra, RU Izo, DE Man, RU ZePe, FR Vend, DE Un, BG Pl K1, BG Pl K2, BG Pl K3, DE Mif, BG Ami, BG Echo$_{af}$, BG Kazino$_{af}$, IZK-L22/16$_{af}$, DE Bal.	2
5.14(38 **Excluding varieties with pod parchment: entire: Pod: thickened wall**			
	absent	0	1
	present	4 бр.: B4/33, B4/34, UK Sugar dwarf, PL Ilu.	9
5.15(39)	**Only varieties with pod: thickened wall: absent: Pod: shape of distal part**		
	pointed	12 бр.: IZK-Musala, IZK-Zornitza, IZK-L22$_4$, IZK-6, IZK-L22/16$_{об}$, IZK-L22/16$_{af}$, IZK-9, IZK-Marsy, DE Mif, UK VikFr, GB Linc, DE Mul;	1
	blunt	45 бр.: IZK-Ran 1, IZK-5, B4/33, B4/34, UK Sugar dwarf, DE-De, NL-Vis, PL Ilu, BG Ami, UK-Vir, EE Pin, SK Du, HU Debr, FR Lux, BG Echo$_{af}$, BG Kazino$_{af}$, IZK-7-intr., IZK-Denitsa, IZK-L101i, RU Flora 6, IZK-Plovdiv, IZK-L1857/3, IZK-L1855/3, DE Di, IZK-L2/17, IZK-L3/17, DE Bal, IZK-1/17, IZK-11, IZK-13, IZK-14, IZK-Vechernitsa, IZK-16, PL Du, IZK-Mira, FR Ofe, IT Bra, RU Izo, DE Man, RU ZePe, FR Vend, DE Un, BG Pl K1, BG Pl K2, BG Pl K3	2
5.16(41)	**Pod:**	**colour**	
	yellow	10 бр.: IZK-Musala, B4/33, B4/34, UK D, EE Pin, IZK-8, IZK-1857/3, UK Sugar dwarf, DE Mif, RU ZePe, DE Un;	1
	green	40 бр.: IZK-Ran 1, IZK-4, IZK-5, IZK-6, DE-De, NL-Vis, PL Ilu, UK-Vir, SK Du, HU Debr, FR Lux, IZK-22/16$_{об}$, BG Echo$_{af}$, BG Kazino$_{af}$, IZK-22/16af., IZK-7-intr, IZK-101i, RU Flora 6, IZK-9, IZK-Plovdiv, IZK-1855/3, DE Di, IZK-2/17, IZK-3/17, UK VikFr, GB Linc, IZK-1/17, IZK-11, IZK-Marsy, IZK-13, IZK- Vechernitsa, IZK-16, PL Du, DE Mul, IZK-Mira, FR Ofe, RU Izo, DE Man, DE Un, BG Pl K2;	2
	blue green	7 бр.: IZK-Zornitza, BG Ami, DE Bal, IT Bra, IZK-14, BG Pl K3, FR Vend;	3
	purple	0	4
5.17(43) **Excluding varieties with pod parchment: entire: Pod: suture strings**			
	absent	0	1
	present	4 бр.: B4/33, B4/34, UK Sugar dwarf, PL Ilu	9

The accessions DE Bal = V36, DE Mul = V46, DE-De = V10, HU Debr = V17, BG Ami = V13, SK Du = V16 were located in the upper part of the dendrogram from which we can conclude that they are genetically very distant from those at the bottom of the dendrogram and they are of medium or low productivity.

Group "B" was consisted only of FR Ofe = V48, many times superior to the other genotypes in terms of pod length and ranked first in the number of grains in the pod. FR Ofe = V48 occupied a position that defines it as a medium-yielding genotype in characteristics the number and weight of seeds of a plant. This indicated that a significant genetic distance was observed between FR Ofe = V48 and the other genotypes included in the study.



IZK-Musala=V1, IZK-Zornitza=V2, IZK-Ran 1=V3, IZK-L22$_4$=V4, IZK-5=V5, B4/33=V6, LB4/34=V7, IZK-6=V8, UK Sugar dwarf =V9, DE-De=V10, NL-Vis=V11, PL Ilu=V12, BG Ami=V13, UK-Vir=V14, EE Pin=V15, SK Du=V16, HU Debr=V17, FR Lux=V18, IZK-L22/16$_{об}$=V19, BG Echo$_{af}$=V20, BG Kazino$_{af}$=V21, IZK-L22/16$_{af}$=V22, IZK-7-intr =V23, IZK-Denitsa=V24, IZK-L101i=V25, RU Flora 6=V26, IZK-9=V27, IZK-Plovdiv=V28, IZK-L1857/3=V29, IZK-L1855/3=V30, DE Mif=V31, DE Di=V32, IZK-L2/17=V33, IZK-L3/17=V34, UK VikFr=V35, DE Bal=V36 GB Linc=V37, IZK-1/17=V38, IZK-11=V39, IZK-Marsy=V40, IZK-13=V41, IZK-14=V42, IZK- Vechernitsa =V43, IZK-16=V44, PL Du=V45, DE Mul=V46, IZK-Mira=V47, FR Ofe=V48, IT Bra=V49, RU Izo=V50, DE Man=V51, RU ZePe=V52, FR Vend=V53

Fig. 1. Cluster analysis of genotypes of garden pea

The results were obtained in the present study reveal the presence of a significant diversity in the collection of accessions of peas in almost all studied characteristics and indicators. The results of cluster analysis and the formation of individual groups showed that genotypes of close origin do not always fall into the same cluster (Ouafi et al., 2016; Gixhari et al., 2014). The assessment of the genetic distance between genotypes can be based on the phenotypic manifestation of the characteristics. Phenotypic diversity by basic characteristics used in technical questionnaires for distinctness, uniformity and stability is also accepted as an assessment of their genetic remoteness (Hanci, 2019).

CONCLUSIONS

Five groups of peas according to the time of flowering according to CPVO-TQ / 007/2 with predominant middle and late time were differentiated.

The database on morphological characters of 57 pea genotypes has been enriched and expanded. The studied materials were without anthocyanin coloration, predominantly medium high with an average number of nodes up to and including first fertile node, with green colour foliage, common leaf type, flecking stipulate, white flowers and two pods per node. The pods were green, short and medium long, medium wide,

with a parchment, blunt shape of distal part of pod, betting an average number of ovules, from which about five light to dark green grains develop in to pods.

The cluster analysis well grouped genotypes by genetic similarity and genetic distance based on the studied characteristics and can be used to plan initial parent combinations in selection. Ecologically distant genotypes showing similarity in the studied characteristics can be included in a crossbreeding scheme very effectively.

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