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ASSESSING THE BREEDING VALUE OF NINE SPRING FIELD PEA (*PISUM SATIVUM* L.) CULTIVARS

ABSTRACT

The investigation was performed during the period 2007-2009 in the second experimental field of institute of Forage Crops, Pleven. Were studies follow varieties: Kristal, Picardi, Amitie, Druzba, Kerpo, Usatii 90, Rezonator, Harkovskii atalon. The variety Pleven 4 was used as a standard. According to the obtained experimental data the varieties could be classified to different groups on earliness. Early are Picardi, Amitie and Harkovskii atalonn with earliness coefficient 1.00, mid – early is Kerpo 1.38 – 1.57 and late varieties Kristal, Druzba, Pleven 4, Usatii 90, Rezonator. Harkovskii atalon is characterized with high lodging resistance only 28.61% from plants are lodging susceptible and it could be including in the future hybridization as donor of essential characters. With highest seed yield are Harkovskii atalonn (207.17 kg × da^{-1}), Kerpo (206.08 kg × da^{-1}) and Usatii 90 (203.33 kg × da^{-1}) what opportunity to be included in breeding programs for high yield varieties.

Key words: forage pea- yield- earliness- productivity

INTRODUCTION

Peas (*Pisum sativum* L.) are grown for hay, pasture or silage production, alone or mixed with cereals, in different parts of the world (McKenzie and Spooner 1999). Pea is a valuable grain legume crop of great importance to adequate nutrition of man and animals with an indisputable contribution to solution of protein problem (Tekeli and Ates 2003, Mihailovic *et al.* 2008). Its favourable chemical composition, great ecological plasticity and adapta-

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tion determine the considerable area of spread and make it an irreplaceable source of protein (Lidanski and Naydenova 1993, Kuzmova 2002, McPhee 2003). Characterization of genetic diversity in crop species has long been based on morphological traits, however, morphological variation is often found to be of limited because expression of morphological traits may be affected by environmental conditions (Bretting and Widrlechner 1995, Nisar *et al.* 2009).

Pea yields are also influenced to a great extent by the environmental conditions and genotype. Therefore the search for donors of particular characters is of priority importance (Mehandjiev *et al.* 2006, Angelova and Stoilova 2008, Acikgoz *et al.* 2009). Natural populations, local and foreign varieties, through which some of disadvantages of the existing bred varieties can be eliminated, serve as main sources of initial breeding material (Kalapchieva 2007).

The objective of this study was to make comparative characterization of nine varieties of spring forage pea with a view to using them as donors of valuable qualities for breeding.

MATERIALS AND METHODS

The investigation was performed during the period 2007-2009 in the second experimental field of institute of Forage Crops, Pleven, Bulgaria, situated in the central part of the Danube hilly plain. The field comparative variety trial was carried by block method in four replications of 5 m^2 plots (2 m × 2.5 m). Each plots included 11 rows with a row spacing 20 cm and sown rate 120 numbers of germinating seeds. Hand planting was applied with depth of sowing 5 cm. The forage pea is grown by approved technology of the Institute of forage Crops – Pleven. Plant material object of the study are nine forms of spring forage pea (*Pisum sativum ssp. sativum L.*) from the our working collection - Kristal, Picardi, Amitie, Druzba, Kerpo (Bulgarian varieties) and Usatii 90, Rezonator and Harkovskii etalon (Ukrainian varieties). The standard variety used Bulgarian variety Pleven 4 officially acknowledged by the State variety commission in Bulgaria. The follow phonological phases and characters were studied: beginning of flowering, sowing – anthesis (day), 50% flowering, maturity, vegetation period (day), earliness (Kuzmova 2002a), plant height (cm), height to first pod (cm), branch number per plant, number of pods per plant, number of seeds per plant, number fertile nodes per plant, branch length (cm), number of seeds per pod, 1000 seeds mass (g), seed weight per plant (g), lodging resistance (%),cracking pods (%, degree), harvest index (Sharma *et al.* 2001), grain yield (kg × da^{-1}). In the technological maturity were analyzed 20 plants (at 10 plants from first and third repetition). In the quality of criteria for estimate degree of the earliness is accepted the date beginning to the

blossoming. Determinate is the period sowing – anthesis as for quantitative estimate is using earliness coefficient. For the ultra-early varieties it is from 1.00 to 1.17, for early 1.18-1.33, for middle-early 1.34-1.66 and for late varieties longer from 1.66.

The data were processed statistically by classical analysis of variance (multi-factor ANOVA). Least Significant Difference (LSD) was computed to compare means with using software STATGRAPHICS Plus for Windows Version 2.1.

RESULTS

Productivity of pea and many cultivated plants depends to a great extent on climatic conditions and individual characteristics of the different varieties (Tamkoc *et al.* 2009). The period of study included years with various climatic conditions, with droughts of different duration and with different rainfall amount (Fig. 1). The year 2007 proved to be unfavourable due to the long drought and high temperatures. The small rainfall amount in March (23.9 mm) and particularly in April (8.5 mm) reflected negatively on seed emergence and further plant development during the growing season. The optimum combination of temperature and moisture in the second year of study (2008) reflected positively on the structural elements of productivity, which resulted in obtaining of high grain yields. The average monthly temperatures were within the range of 9.8 to 25.5ºC and the rainfall amount varied from 17.1 to 78.1 mm.

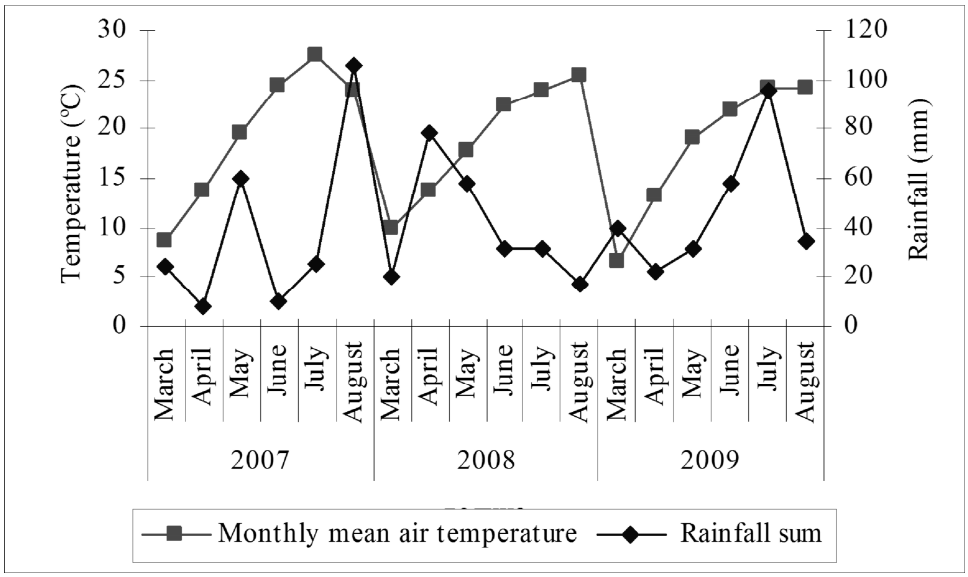

Fig. 1. Cilmatic characterization of the experimental period

The harvesting year 2009 occupies an intermediate position, as compared to the other years of study, being characterized by higher temperatures in May (19.1ºC), as against the previous year and an increased rainfall amount in June (58.4 mm).

The data on phenological characteristics (Table 1) shows that practically there were no varietal differences during the period from sowing to emergence. In 2008, the phenological stage of full emergence in Picardi, Amitie and Kerpo occurred 3-4 days earlier (on 4.04.), as against the other varieties.

Table 1

Phenological development of the forage pea cultivars (2007-2009)

Phenology	Cultivar									
	Years	Pleven 4	Kristal	Picardi	Amitie	Druzba	Kerpo	Usatii 90	Rezonator	Harkovskii etalon
Sowing date	2007	13.03	13.03	13.03	13.03	13.03	13.03	13.03	13.03	13.03
	2008	21.03	21.03	21.03	21.03	21.03	21.03	21.03	21.03	21.03
	2009	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03	31.03
50% emergence	2007	7.04	7.04	7.04	7.04	7.04	7.04	7.04	7.04	7.04
	2008	7.04	8.04	4.04	4.04	7.04	4.04	8.04	8.04	8.04
	2009	9.04	9.04	9.04	9.04	9.04	9.04	9.04	9.04	9.04
Beginning of flowering	2007	12.05	14.05	7.05	7.05	11.05	11.05	11.05	15.05	7.05
	2008	21.05	21.05	12.05	12.05	21.05	17.05	21.05	21.05	12.05
	2009	18.05	17.05	13.05	13.05	20.05	16.05	21.05	20.05	13.05
Sowing-anthesis [days]	2007	60	62	55	55	59	59	58	62	55
	2008	61	61	52	52	61	57	61	61	52
	2009	48	47	43	43	50	46	51	50	43
50% flowering	2007	18.05	18.05	10.05	10.05	22.05	16.05	18.05	18.05	11.05
	2008	4.06	2.06	20.05	20.05	31.05	26.05	31.05	2.06	24.05
	2009	28.05	28.05	13.05	13.05	20.05	16.05	21.05	20.05	13.05
Maturity	2007	21.06	18.06	4.06	4.06	14.06	12.06	18.06	18.06	12.06
	2008	26.06	20.06	19.06	19.06	23.06	23.06	26.06	26.06	20.06
	2009	26.06	22.06	17.06	17.06	23.06	22.06	22.06	23.06	17.06
Growth period [days]	2007	100	97	83	83	93	91	96	96	90
	2008	97	91	90	90	94	94	97	97	91
	2009	79	76	69	69	75	74	74	75	69
Earliness coefficient	2007	1.71	2.00	1.00	1.00	1.57	1.57	1.43	2.00	1.00
	2008	2.00	2.00	1.00	1.00	2.00	1.56	2.00	2.00	1.00
	2009	1.63	1.50	1.00	1.00	1.88	1.38	2.00	1.88	1.00

The beginning of flowering varied from the first to the third 10-day period of May. Picardi, Amitie and Harkovskii etalon had the earliest beginning of flowering, followed by Kerpo. The same varieties showed a more accelerated rate of flowering. Their full flowering was 12 to 15 days earlier than the other varieties and the duration of the period of sowing-beginning of flowering was the shortest for the three years of study, 55, 52 and 43 days, respectively. Except for Rezonator (62, 61 and 50 days) and Pleven 4 (60, 61 and 48 days), the standard Kristal (62, 61 and 47 days) was inferior to the other varieties in this character.

Table 2

Morphological characteristics of the forage pea cultivars (2007-2009)

Characters	Cultivar								
	Pleven 4	Kristal	Picardi	Amitie	Druzba	Kerpo	Usatii 90	Rezonator	Harkovskii
Plant height	71.80 b	43.18 a	31.90 a	30.72 a	41.00 a	44.22 a	76.10 b	69.55 b	42.00 a
Height to first pod, [cm]	28.73 cd	25.07 abc	17.08 a	17.63 ab	28.75 cd	28.88 cd	52.87 e	38.48 d	27.43 bc
Branch number	0.88 b	0.55 ab	0.30 a.	0.27 a.	0.40 ab.	0.37 ab.	0.02 a	0.10 a	-
Number of pods	10.10 b	7.02 ab	4.70 a	4.32 a	4.35 a	5.65 a	4.72 a	5.40 a	4.45 a
Number of seeds	40.17 b	23.28 a	13.37 a	15.13 a	18.13 a	18.58 a	19.70 a	21.23 a	10.70 a
Fertile nodes per plant [number]	6.68 b	4.18 a	2.77 a	2.97 a	3.18 a	3.42 a	2.55 a	3.22 a	2.78 a
Branch length	54.34 b.	24.25 ab	11.71ab	13.84 ab	20.47 ab.	21.82 ab.	54.50 b.	17.13 ab.	-
Number of seeds	3.94 bc	3.41ab	3.52 ab	3.97 bc	4.60 c	3.57 ab	4.04 bc	3.81abc	2.95 a
1000 seeds mass	160.53 a	246.31 b	253.82 bc	251.63 bc	190.88 a	266..25 bc	290.02 cd	267.37 bcd	307.44 d
Seed weight per	6.03 c	5.27 abc	3.33 a	3.96 ab	3.38 a	4.48 abc	5.61 bc	5.71bc	3.56 a
Lodging resistance [%]	49.49 b.	36.99 ab	46.68 ab.	52.17 ab	39.16 ab	54.28 ab	32.27 ab.	39.70 ab	28.61 a.
Cracking pods	18. (2) a	20. (2) b	22. (2) a	18. (2) a	4. (4) b	2. (4) c	1. (4) c	2. (4) c	1. (4) c
Harvest index	0.19 a	0.26 ab	0.45 bc	0.38 abc	0.41 abc	0.44 abc	0.35 abc	0.32 ab	0.58 c

a, b, c, d, e statistically proven differences in P=0.05

The observed differences in the occurrence of the particular phenological stages for the studied varieties remained until the end of the growing season. It varied from 69 to 90 days in Picardi, Amitie and Harkovskii etalon and from 75 to 100 days in Pleven 4 and Rezonator.

Picardi, Amitie and Harkovskii etalon having a coefficient of early ripeness of 1.00 can be assigned to the group of early ripening varieties, Kerpo (from 1.38 to 1.57) to the mid-early ripening and Pleven 4, Kristal, Druzba, Usatii 90, Rezonator to the late ones.

According to the obtained experimental data (Table 2), the tested genotypes are characterized by significant differences between them with regard to plant height. The variation was within the range from 30.72 in Amitie to 76.10 cm in Usatii 90 that was superior to Kristal (43.18 cm) to a great extent with significant differences.

The sufficiently high initiation of first pod is an important requirement contributing to crop harvesting without losses (Kalapchieva 2002). The varieties forming longer stems initiate the first pod at a greater height. With regard to this character, Usatii 90 and Rezonator showed higher significant values (52.87 cm and 38.48 cm), as against the standard (20.07 cm).

The study of the main elements of productivity is an important stage to determine the best variety for the concrete agroclimatic conditions. It is evident from the analysis of the results that Pleven 4 differed significantly from the other varieties and had the greatest number of branches (0.88), pods (10.10) and seeds (40.17) per plant, but it, together with Amitie and Picardi, had a very high degree of pod dehiscence (score 2). The pods of the other varieties dehisced more slightly (score 4).

The increase of productive potential of the varieties was related to the number of fertile nodes per plant (Yurevich 2008). With regard to this character, Pleven 4 formed the greatest number of fertile nodes (6.68) and was significantly superior to the other varieties in times in this character.

Pleven 4 was the smallest-seeded having a 1000-seed weight of 160.53 g, Kristal was medium-seeded with 246.31 g and the seeds of Harkovskii etalon (307.44 g) and Usatii 90 (290.02 g) were the largest.

The relatively greater number of seeds and branches in Pleven 4 determined also the high grain weight per plant (6.03 g). With regard to this character, the differences between Kristal (5.27 g), Rezonator (5.71 g) and Usatii 90 (5.61 g) were small and nonsignificant.

The low degree of plant lodging is of particular importance to the pea varieties, because it favours the considerable reduction of grain losses during mechanized harvesting (Skubisz 2002, Taran *et al.* 2003, Zhang 2004, Zhang *et al.* 2006). Variety Harkovskii etalon was characterized by the best lodging resistance (28.61%) and Kerpo (54.28%) and Amitie (52.17%) had the lowest one.

The yield index as a productive character is genetically conditioned to a great extent (Mihailovic and Mikic 2004). The varieties with smaller stem length have higher values of yield index, as against those with a longer stem. Harkovskii etalon (0.58) was significantly superior to Kristal (0.26). Amitie (0.45) and Kerpo (0.44) also had a greater index, but with nonsignificant differences.

The grain yields changed during the different years depending on the climatic conditions (Table 3).

Table 3

Grain yield of the forage pea cultivars (2007-2009)

Cultivars	2007		2008		2009	
	[kg × da^{-1}]	Versus standard [%]	[kg × da^{-1}]	Versus standard [%]	[kg × da^{-1}]	Versus standard [%]
Pleven 4	102.00	100.00	229.00	100.00	71.50	100.00
Kristal	125.46	123.00	279.50	122.05	89.00	124.48
Picardi	114.50	112.25	295.50	129.04	106.50	148.95
Amitie	110.00	107.84	322.65	140.90	122.50	171.33
Druzba	101.75	99.75	326.50	142.58	98.50	137.76
Kerpo	132.75	130.15	313.00	136.68	172.50	241.26
Usatii 90	137.50	134.80	320.00	139.74	152.50	213.29
Rezonator	155.75	152.70	270.50	118.12	144.50	202.10
Harkovskii etalon	117.50	115.20	264.00	115.28	240.00	335.66

The genotypes gave an average grain yield (Figure 2) of 122.50 kg da^{-1} in Pleven 4 to 207.17 kg da^{-1} in Harkovskii etalon.

The varieties had the lowest productivity in 2007 and 2009 that were characterized by relatively low rainfall and a cool spring. In 2008, the varieties were well seeded and showed their potential capabilities to a greater extent.

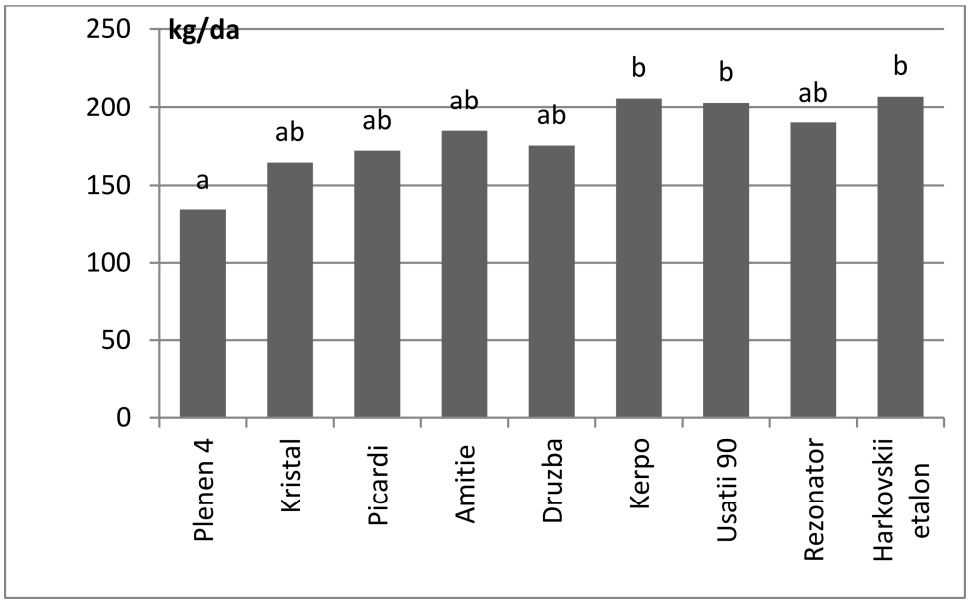

Fig. 2. Average grain yield for the period 2007-2009, kg × da^{-1}, a, b, c, d, e statistically proven differences in P=0.05

DISCUSSION

The analysis of the obtained results shows that the major factor for the higher yielding capacity of the studied varieties is the optimum combination of the yield elements and not so much their maximum manifestation. The knowledges for genotype of the initial forms, the environment and the interaction between them determines the correct direction of selection (Bourion *et al.* 1998, Pachev *et al.* 2009).

The Earliness coefficient allow the studies varieties to be classified to different groups on earliness. Early are Picardi, Amitie and Harkovskyi atalonnyi with earliness coefficient 1.00, mid – early is Kerpo 1.38 – 1.57 and late varieties Kristal, Druzba, Pleven 4, Usatyi 90, Rezonator.Harkovskii atalon is characterized with high lodging resistance only 28.61% from plants are lodging susceptible and it could be including in the future hybridization as donor of essential characters.With highest seed yield are Harkovskii atalonn (207.17 kg da^{-1}), Kerpo (206.08 kg da^{-1}) and Usatii 90 (203.33 kg da^{-1}) what opportunity to be included in breeding programs for high yield varieties.

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