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EVALUATION OF THE PRODUCTIVITY COMPONENTS IN POTATO BREEDING MATERIALS

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ABSTRACT: Productivity components of seven mid-early potato varieties and lines (E 28, E 30, E 68, E 102, E 199, E 330, Sante) had been studied and estimated during period 2003-2005 in the Institute of Vegetable Crops-Maritza, Plovdiv. The purpose of the present study was to estimated productivity components of potato varieties and lines from the mid-early group by ripeness and the effect of genotype, year, ecological region and interaction between them on the expression of these characters in the studied material to be established.

The lines E 68 (5.6) and E 30 (5.3) were characterized with the greatest stem number per plant and the lines E 102 (118.9g) and E 199 (90.2 g) with the highest standard tuber weight. Highest standard productivity was recorded in E 102 (4340 kg/dka), E 199 (4045 kg) and E 68 (4006 kg/dka).

The phenotypic variability of main productivity components (stem number per plant, tuber number per stem and standard tuber weight) wae due mainly to genotypic differences between studied lines and varieties while the variation of their derivatives (tuber number and weight per cluster) mainly on the conditions of the year and its interaction with genotype and ecological zone.

Key words: *potato, breeding, productivity components, mean tuber weight, number of tubers*

INTRODUCTION: The potato productivity is a complex quantitative character that is under control of great number of genes each of them with a slight effect while the influence of the environmental factors is strong (Yashina, 1970). The main components of the productivity are the following: stem number per plant, tuber number per stem, average tuber weight and productivity from a cluster (Zrust et al., 1999). Potato selection and productivity evaluation should be performed at such mutual combination of the chosen components that provides biggest yield of high quality production per unit area (Tarn and Tai, 1983).

According to Ross (1986) tubers number per cluster was genetically determined from the stems number as on each stem forms 2,5 to 4,5 tubers were formed. The large tuber size also depended mainly on the genotype (Howard, 1978) but in comparison with their number it exerted smelled influence caused by the environmental factors and as a result of this it appeared to be more reliable character for productivity evaluation and selection.

The purpose of the present study was to estimated productivity components of potato varieties and lines from the mid-early group of ripeness and the effect of genotype, year, ecological region and interaction between them on the expression of these characters in the studied material to be established.

Materials and methods

The investigation was performed during period 2003 - 2005 in two ecological regions of the experimental field in the "Maritsa" Vegetable Crops Research Institute - Plovdiv with altitude 160 m^2 and in the high mountain base - Pavelsko village with altitude 1500 m^2. Seven potato lines and varieties (E 28, E 30, E 68, E 102, E 199, E 330 and variety Sante as a control) from the mid-early group according to

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ripeness were included. The trial was performed by block method in 4 replications (100 plants in replication), distance - 75/25 cm and experimental plot size - 18.5 m^2. The planting was made during the first ten days of March in Plovdiv while in Pavelsko - during the first ten days of May. Experiments were performed according to the agricultural practices for mid-early potato production, adopted in Bulgaria.

The stem number per plant was recorded during vegetation period while the remaining components of productivity as formed tubers number per stem, average weight of one standard tuber, tubers number per cluster (standard, non-standard and total), tubers weight per cluster (standard and non-standard) were recorded in harvesting.

The obtained data were mathematically processed by three-way analysis of variance (Lakin, 1990) and Duncan Multiple range test (1995).

Results and discussion

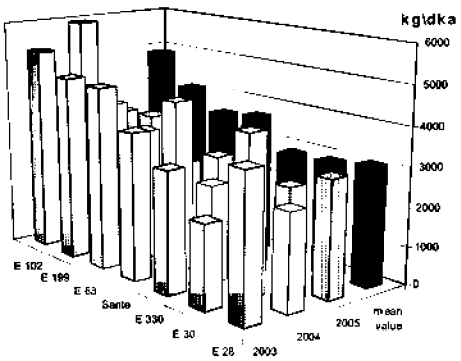
The studied collection of potato varieties and lines was described with significant diversity with respect to the productivity components (Table 1).

The stem number per plant varied from 2.1 in line E 330 (Pavelsko, 2005) up to 6.95 in E 30 (Pavelsko, 2005). The standard variety Sante had the greatest amplitude of variation by regions and years - from 2.55 (Plovdiv, 2004) up to 5.8 (Pavelsko, 2003). The highest average values was reported in E 68 (5.6) and E 30 (5.3) while the lowest one in E 102 (2.9).

Comparatively lower variation was observed of tuber number per stem which was 1.8 in E 68 (Plovdiv, 2005) up to 5.7 in E 28 (Pavelsko, 2004). The results from Duncan test showed that in 2004. in Plovdiv and in 2005. in Pavelsko studied breeding lines did not differ significantly by the tuber number formed per stem. It was proven that the highest expression of this character was recorded in E 28 (4.2). What made an impression was the fact that the same line differed with small stem number (3.6). At the same time the lines with great stem number E 68 and E 30 were described with the smallest tuber number per stem which was an indication for presence of negative relation ship between two characters. Different combination between them in the studied material determined variation of the following productivity component - total tuber number per cluster. The amplitude of this component varied from 4.8 in E 102 (Pavelsko, 2003) up to 19.1 in E 28 (Pavelsko, 2004). The proven highest were lowest values were E 28 (15.1) and E 102 (9.0), respectively. They differed significantly from all remaining breeding materials. Both lines keep their maximal (12.1) and minimal (6.8) value regarding the number of standard tubers per cluster. The character was described with comparatively high variability both by years and by regions, expressed within 4.3 (E 102, Pavelsko, 2003) up to 16.0 (E 28, Pavelsko, 2004). The amplitude had the greatest values in E 68 (6.85 - 15.2).

Significant diversity in the average standard tuber weight -varying from 46.6 g (E 28, Plovdiv, 2005) up to 152.3 g (E 102, Pavelsko, 2005) was recorded in the studied breeding material. On the other side the highest expression was observed in lines E 102, E 199 and E 330 that had the lowest average values of standard tuber number per cluster. We suppose the presence of negative correlation between the fruit number and weight which was proven in certain vegetable crops as red pepper (Todorova et al, 2003), garden pea (Kalupchieva, 2003), brussels sprouts (Mihov and Antonova, 2001).

Fig.1 Standard productivity of potato breeding material in region of Plovdiv



Significant phenotypic diversity of productivity in potato lines and varieties was observed as a result of different combinations between the studied components (Figure 1, 2). The standard yield of E 102 (4340 kg/dka), E 199 (4045 kg/dka) and E 68 (4006 kg/dka) was the highest one. High productivity of the first two lines was due to the combination of high average tuber weight and high percent-

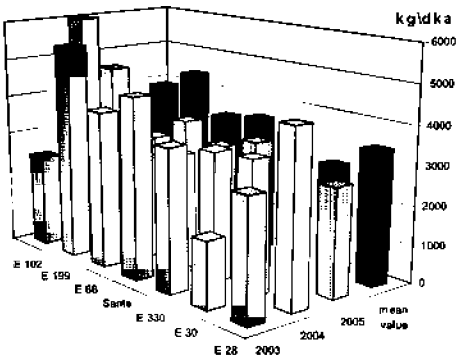
age of standard production while in E 68 it was due to combination of greater stem number and greater tuber number per cluster. These three breeding lines exceeded by yield the control variety Sante which was described with great tuber number per plant but with lower average weight, lower percentage of standard production and considerable variation by years. The widest amplitude of variation by years and regions was registered in E 330 (2478 - 5990 kg/dka).

Tab. 1. Productivity components in potato breeding materials

Region Year	E 28	E 30	E 68	E 102	E 199	E 330	Sante
	Stem number per plant						
Plovdiv 2003	3.25 b	5.80 a	6.85 a	2.95 b	3.65 b	3.00 b	3.45 b
Pavelsco 2003	3.75 ab	4.80 a	5.25 a	2.40 b	3.45 ab	3.95 ab	5.80 a
Plovdiv 2004	3.40 bcd	4.40 ab	4.95 a	3.90 abc	3.75 bcd	2.40 d	2.55 cd
Pavelsco 2004	3.35 cd	4.50 bc	6.75 a	2.45 d	3.80 bcd	4.00 bc	5.00 b
Plovdiv 2005	4.25 ab	5.40 a	4.25 a	3.25 b	3.35 b	3.15 b	3.45 b
Pavelsco 2005	3.60 b	6.95 a	5.55 a	2.45 b	3.00 b	2.1 b	3.35 b
Mean value	3.6 bc	5.3 a	5.6 a	2.9 c	3.5 bc	3.1 c	3.9 b
	Tuber number per stem						
Plovdiv 2003	4.40 a	2.40 ab	2.00 b	4.25 ab	3.60 ab	2.65 ab	4.10 ab
Pavelsco 2003	4.45 a	3.05 ab	2.55 ab	2.00 b	2.95 ab	4.40 a	2.60 ab
Plovdiv 2004	3.05 ns	2.80 ns	2.45 ns	3.40 ns	3.10 ns	3.45 ns	4.00 ns
Pavelsco 2004	5.70 a	2.10 c	2.30 bc	3.60 b	2.45 bc	3.25 bc	2.70 bc
Plovdiv 2005	3.50 a	2.60 ab	1.80 b	2.45 ab	2.45 ab	2.50 ab	3.30 a
Pavelsco 2005	4.10 ns	2.05 ns	2.10 ns	2.90 ns	2.85 ns	2.95 ns	2.50 ns
Mean value	4.2 a	2.5 bc	2.2 c	3.1 b	2.9 bc	3.2 b	3.2 b
	Total tuber number per plant						
Plovdiv 2003	14.3 a	13.9 a	13.7 ab	12.5 b	13.1 b	7.9 c	14.2 a
Pavelsco 2003	16.6 a	14.6 b	13.4 bc	4.8 d	10.2 c	17.3 a	15.1 ab
Plovdiv 2004	10.4 ab	12.3 ab	12.1 ab	13.3 a	11.6 b	8.2 a	10.2 ab
Pavelsco 2004	19.1 a	9.5 c	15.5 b	8.8 c	9.3 c	13.0 bc	13.5 bc
Plovdiv 2005	14.8 a	14.0 a	7.7 b	8.0 b	8.2 b	7.8 b	11.4 ab
Pavelsco 2005	14.8 a	14.2 a	11.7 ab	7.1 bc	8.6 b	6.1 c	8.4 b
Mean value	15.1 a	13.0 ab	12.3 bc	9.0 d	10.2 cd	10.0 cd	12.4 ab
	Standard tuber number per plant						
Plovdiv 2003	12.45 a	7.15 c	13.20 a	8.00 bc	11.50 ab	6.35 c	10.15 b
Pavelsco 2003	12.30 a	5.90 c	12.85 a	4.35 c	9.60 b	12.80 a	12.10 a
Plovdiv 2004	9.05 ab	10.65 ab	11.20 a	9.10 ab	9.20 ab	6.65 b	9.65 ab
Pavelsco 2004	16.00 a	8.40 b	15.20 a	7.05 b	8.00 b	11.50 ab	12.00 ab
Plovdiv 2005	12.20 a	7.65 b	6.85 b	6.40 b	6.05 b	6.40 b	7.70 b
Pavelsco 2005	10 60 a	9.45 b	10.40 a	5.90 b	7.25 ab	4.90 b	7.20 ab
Mean value	12.1 a	9.45 a	11.6 a	6.80 c	8.6 bc	8.10 bc	9.8 ab
	Standard tuber weight (g)						
Plovdiv 2003	56.1 c	57.1 c	67.3 c	124.7 a	78.0 bc	92.8 b	70.4 bc
Pavelsco 2003	47.4 c	54.3 c	75.9 b	89.7 a	89.4 a	88.3 a	71.3 b
Plovdiv 2004	52.0 c	72.2 bc	57.6 bc	122.9 a	80.2 bc	72.1 bc	85.5 b
Pavelsco 2004	52.4 c	75.3 b	61.4 bc	125.3 a	114.6 a	75.4 b	63.4 bc
Plovdiv 2005	46.6 d	62.9 cd	65.4 cd	98.5 a	106.6 a	86.6 ab	68.1 bc
Pavelsco 2005	49.8 c	64.2 bc	62.3 bc	152.3 a	72.5 bc	95.5 b	69.2 bc
Mean value	50.7 d	64.3 bc	65.0 c	118.9 a	90.2 b	85.1 b	71.3 c

a, b, c, d - Duncan Multiple range test ($p<0.05$)

Fig.2 Standard productivity of potato breeding material in region of Pavelsko



Phenotypic differences in productivity of studied potato lines and varieties that were observed supposed the presence of genetically determined diversity that created a great possibility for selection. A proof for this suggestion could be found in the results of three-way analysis of variance of the productivity characters (Table 2). Data from the analysis of variance showed that differences in the response of the main productivity components - stem number per plant, tuber number per stem and average standard tuber weight were due basically to different inheritable potential of the potato varieties and lines, included in the study and its interaction with environmental factors while the expression of their derivatives - tuber number and weight per cluster (standard, non-standard and total) depended mainly on the conditions of the year and its interaction with genotype and ecological zone. The effect of region conditions on standard tuber number in cluster was proven.

Tab. 2. Analisis of variance of the productivity components in potato breeding materials

Source of variation	Stem number per plant	Tuber number per stem	Tuber number per plant			Weight of one standard tuber	Tuber weight per plant		
			standard	Non standard	total		standard	Non standard	total
Year (A)	0.84	2.06	32.79**	7.63*	2.13	91	247043**	1464**	282798**
Ecologcal region (B)	0.94	0.02	21.01*	0.03	19.05	34	47500	40	44712
Genotype (C)	13***	4.8***	45.5***	10.1***	54.7***	6038***	92818*	825**	86346*
Interaction (AxB)	0.98	0.18	4.71	11.3***	0.01	164	8129	130	10188
Interaction (AxC)	1.26*	0.11	7.14	1.51	4.74	239**	55398	498**	64354
Interaction (BxC)	1.60*	1.78*	11.04*	1.36	14.07	60	40394	52	42448
Interaction ABC	1.39*	1.01	13.19**	2.99	11.62	557**	92402**	432*	103949**
Error	0.55	0.72	5.08	1.79	7.52	95	33891	195	37933

* p< 0.05 ** p< 0.01 *** p< 0.001

Conclusion

The studied potato lines and varieties weae described with significant phenotypic diversity of the productivity components. Stem number per plant was the greatest in line E 68 (5.6) and line E 330 (5.3); greatest tuber number per stem was found in E 28 (4.2) and highest standard tuber weight was found in E 102 (118.9 g) and E 199 (90.2 g).

Highest standard productivity was recorded in E 102 (4340 kg/dka), E 199 (4045 kg/dka) and E 68 (4006 kg/dka).

The phenotypic variability of main productivity components (stem number per plant, tuber number per stem and standard tuber weight) was due mainly to genotypic differences between studied lines and varieties while the variation of their derivatives (tuber number and weight per cluster) depended mainly on the conditions of the year and its interaction with genotype and ecological zone.

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SUMMARY

During the period 2003-2005 in the Institute of Vegetable Crops-Maritza, Plovdiv the productivity components of seven mid-early potato varieties and lines (E 28, E 30, E 68, E 102, E 199, E 330, Sante) have been studied and estimated. The purpose of the present study was the productivity components of potato varieties and lines from the mid-early group by ripeness to be estimated and the effect of genotype, year, ecological region and interaction between them on the expression of these characters in the studied material to be established.

The studied potato lines and varieties are described with significant phenotypic diversity of the productivity components (tabl.1). Stem number per plant is the greatest one in line E 68 (5.6) and line E 330 (5.3); greatest tuber number per stem has in E 28 (4.2) and with highest standard tuber weight is E 102 (118.9 g) and E 199 (90.2 g).

Highest standard productivity (fig.1 and 2) is recorded in E 102 (4340 kg/dka), E 199 (4045 kg/dka) and E 68 (4006 kg/dka).

The phenotypic variability (tabl 2.) of main productivity components (stem number per plant, tuber number per stem and standard tuber weight) is due mainly to genotypic differences between studied lines and varieties while the variation of their derivatives (tuber number and weight per cluster) depends mainly on the conditions of the year and its interaction with genotype and ecological zone.