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VARIABILITY OF ECONOMIC TRAITS OF 28 CULTIVARS OF ASPARAGUS (*ASPARAGUS OFFICINALIS* L.)

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Summary

The research which aim was to characterise variability of economic traits of 28 asparagus cultivars was carried out in the Marcelin Experiment Station in the years 2004-2008. Variability of total and marketable yields, the mean weight of green spears as well as plant survival of all the 28 cultivars and separately of nine German and Dutch cultivars was evaluated. In addition, variability between harvest years of individual cultivars for total and marketable yields, mean spear weight in five and spear thickness in three selected harvest years was characterised.

Variability between cultivars was found greater with respect to marketable and total yields expressed in the weight of harvested spears and smaller with respect to mean spear weight and total yield expressed in the number of harvested spears. Less productive cultivars exhibited the least consistent yields between individual harvest years and the worst plant survival. Higher yield consistency, mean spear weight and plant survival were observed in the group of German and Dutch cultivars.

key words: *Asparagus officinalis* L., diversity, yield, spear quality, plant survival

INTRODUCTION

Well-managed asparagus plantings can be harvested in Poland for at least ten years. Therefore, using proper cultivars for establishment of new plantations is very important.

Results of numerous trials carried out world-wide proved that the performance of asparagus cultivars depends not only on their genetic potential but also on ability for adaptation to environmental conditions (Hartmann 1987, Drost 2002, Knaflewski & Kałużewicz 2004). The best results were obtained with cultivars bred in countries with similar climatic conditions to these in which they were grown (Maurer & Hodgins 1984, Boonen *et al*. 1990). The most suita-

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ble for white asparagus production in Poland appeared to be Dutch and German cultivars and the least suitable Californian (Knaflewski & Konys 1993, Knaflewski & Żurawicz 2003).

Great differences were found among asparagus cultivars in morphological characteristics (Knaflewski *et al*. 2007). Some of summer stalk characteristics were closely correlated with the yield and its quality (Ellison & Scheer 1959, Moon 1976, Chen 1979, Hartmann 1985, Knaflewski 1985, 1994). The differences between cultivars increased with ageing of asparagus plantings (Boonen *et al.* 1979, Hartmann 1984). Usually, yields increase up to 4^{th}-5^{th} year of harvesting and decline later on. In older plantings it is the mean spear weight that decreases most (Hartmann 1984). Cultivars originating from countries with different climate and less adapted to given growing conditions were more seriously infected by root and stem diseases caused by *Fusarium spp.* and died earlier (Blanchette *et al*. 1982, Sadowski & Knaflewski 1990)

The objective of the performed research was to evaluate the variability of economic traits of 28 asparagus cultivars in the course of 5-year period of harvesting.

MATERIAL AND METHODS

In the years 2004-2008 evaluation of the level and quality of yields was carried out of 28 asparagus cultivars originating from 10 countries and different parts of the world. The trial was established in the year 2000 on plots measuring 14.4 m^2 on each of which 20 plants at 1.8 x 0.4 m spacings were planted. A random block design in two replications was employed.

Green spears approximately 20 cm long were harvested once a day. After harvest, they were separated into quality classes and then counted and weighed. Spears less than 6 mm in diameter, strongly bent and hollow spears as well as with loose heads were treated as non-marketable yield. The level of the total and marketable yield was determined as well as the number of spears in the total yield and the mean spear weight of the marketable yield. Analysis of variance with test F was performed for the above-mentioned traits and the significance of differences between means was established on the basis of the Newman-Keuls test at the significance level of P=0.95.

On the basis of the number of plants on experimental plots in 2008 in relation to the number of plants planted out, the so called plant survival was determined. For this trait as well as for the level of yield and mean spear weight, means and coefficients of variability were calculated for all the 28 experimental cultivars and, additionally, only for Dutch and German cultivars.

In order to characterise yielding variability between years in individual cultivars, coefficients of variability were calculated for the level of the total and marketable yields, the number of spears in the total yield as well as for the mean spear weight of the marketable yield. In addition, variability of the spear thickness in years 2005, 2007 and 2008 was calculated. Thickness measurements were carried out half through the length of each spear. In the years 2005 and 2008, all

spears from two harvests were measured, whereas in 2007 - all spears from one harvest.

RESULTS AND DISCUSSION

The total asparagus yield ranged from about 2 $t \cdot ha^{-1}$ in cultivar 'Gloria' to about 10 $t \cdot ha^{-1}$ in the case of the 'Gynlim' cultivar (Table 1). Mulder and Lavrijssen (2008) compared 43 asparagus cultivars in cultivation for white spears and confirmed very high variations in yield levels between individual cultivars. As in the case of our experiments, the cultivar which yielded the highest harvest of very good spear quality was also cultivar 'Gynlim'.

The mean spear weight ranged from 16-17 g in the 'Tsuki-kho 3' and 'Diego' cultivars to 45 g in cultivar 'Grolim'. In the eighth year after planting, at least 90% of plants of cultivars 'Gynlim', 'Ramada' and 'Taramea' survived, while in the case of 'Tsuki-kho 3' and 'PLA-P2232'-50-55%, 45% of the 'Purple Passion' cultivar and in the case of 'Gloria' cultivar only 7.5% of plants remained alive.

The highest variability among the investigated 28 cultivars was determined in the yield level expressed in weight (38-41%) and lower in yields expressed in the number of spears and their mean weight (28%). Variations in plant survival turned out to be the lowest (24.1%). Dutch and German cultivars were characterised by considerable consistency both with respect to yield levels and mean spear weight (20-22%). Coefficient of variability for plant survival was exceptionally small (7.4%). Consistency similar to that as in Dutch and German cultivars regarding total and marketable yields was also reported by Ye Jinsong (2002) in China in an experiment in which 31 asparagus cultivars derived from different countries were compared.

The highest consistency between years of the total and marketable yields expressed in the weight of harvested spears was observed in the case of 'Aarslev 270' and 'Hannibal' (Table 2), while of the total yield expressed in the number of spears was in 'Alpha' and 'Aarslev 270'. It was observed that less productive cultivars like: 'Gloria', 'Tsuki-kho 3' and 'Purple Passion' were characterised by the least consistent yields between individual harvest years and by the worst plant survival in the 8th year after planting. Also cultivar 'PLA-2132' was characterised by considerable yield variability between years. Knaflewski *et al*. (2001), on the basis of an experiment performed in the years 1990-2000, found that in some cultivars lower yields in consecutive harvest years were caused by strong dying out of plants. In the above mentioned trial, in the 10th year of cultivation, only 14-15% plants remained alive in the case of the least productive cultivars.

During five years of harvest, the mean spear weight underwent the least changes in the case of German cultivars 'Hannibal' and 'Eposs', Dutch cultivar 'Grolim' and Danish 'Aarslev 270' cultivar (Table 2), whereas the greatest changes in mean spear weight were recorded in the French cultivar 'Jacq. Ma. 2014' and Spanish PLA-2132.

Table 1. Total and marketable yield, mean spear weight and plant survival as well as variability of these traits in 28 asparagus cultivars (2004-2008)

Cultivar	Origin	Yield			Mean marketable spear weight (g)	Plant survival (%)
		total		marketable ($t \cdot ha^{-1}$)		
		($t \cdot ha^{-1}$)	('000) spears			
Gynlim	NL	9.9 a*	314 a	8.9 a	31 cd	97.5
Hannibal	DE	9.5 ab	312 a	8.4 ab	31 cd	87.5
Ravel	DE	9.2 a-c	318 a	8.0 a-c	29 d-f	82.5
Ramos	DE	8.6 a-c	309 a	7.3 bc	28 d-g	85.0
Andreas	FR	8.5 a-c	245 b	6.7 c	35 b	70.0
Ramada	DE	8.2 a-c	251 b	7.0 c	33 bc	90.0
Fileas	FR	7.9 bc	240 b	6.6 c	33 bc	75.0
Grolim	NL	7.7 cd	171 c-f	6.9 c	45 a	87.5
Ariane	DE	7.5 c-e	306 e	6.6 c	24 g-k	80.0
Eposs	DE	6.6 f-i	208 b-e	4.6 d-g	27 e-h	75.0
Taramea	NZ	6.4 d-f	331 a	5.4 d	19 m-o	90.0
Jacq. Ma. 2004	FR	6.3 d-g	206 b-e	4.7 d-f	31 cd	72.5
Aarslev 270	DK	6.1 e-h	234 bc	5.1 de	26 e-i	77.5
Alpha	DE	5.5 f-i	220 b-d	4.7 d-f	25 f-j	85.0
Abril	ES	5.4 f-i	223 b-e	4.4 d-g	24 g-l	72.5
Cipres	ES	5.1 f-j	172 c-f	4.4 d-g	30 c-e	87.5
PLA-P2232	ES	5.1 f-j	191 b-f	4.5 d-g	26 e-i	55.0
JWC-1=ASP1	NZ	5.0 f-j	229 bc	4.4 d-g	22 j-m	62.5
Jacq. Ma. 2014	FR	4.7 f-j	202 b-e	3.7 e-g	23 h-m	62.5
Trigal	ES	4.5 g-j	207 b-e	3.7 e-g	21 j-n	72.5
Sartaguda	ES	4.5 g-j	204 b-e	3.6 e-g	22 i-m	87.5
Tainan 2	TW	4.3 h-j	210 b-e	3.7 e-g	20 k-n	80.0
Diego	IT	4.2 ij	237 b	3.7 e-g	17 mo	75.0
PLA-2132	ES	4.0 ij	155 ef	3.3 f-h	23 h-m	77.5
Tainan 3	TW	3.3 jk	162 d-f	2.9 g-i	20 k-n	80.0
Purple Passion	US	2.4 k	94 h	2.1 hi	26 e-h	45.0
Tsuki-kho 3	JP	2.4 k	141 fg	2.0 i	16 o	52.5
Gloria	FR	2.2 k	106 gh	0.9 j	20 l-n	7.5
Mean		5.9	221	4.9	26	74.0
Coefficient of variability (%)		37.6	28.0	40.6	24.2	24.1
Only Dutch and German cultivars						
Mean		8.0	267	6.9	30.0	85.6
Coefficient of variability (%)		19.6	21.0	21.6	21.0	7.4

*- means followed by the same letter do not differ significantly at P=0.95

Table 2. Yield variability between harvest years in individual cultivars of asparagus (2004-2008)

Cultivar	Coefficient of variability (%)			
	Yield			Mean marketable spear weight (g)
	total		marketable ($t \cdot ha^{-1}$)	
	($t \cdot ha^{-1}$)	('000) spears		
Aarslev 270	21.3	18.9	21.2	9.1
Hannibal	22.3	23.1	21.1	7.7
Alpha	23.6	17.3	23.4	10.7
Grolim	24.9	21.7	26.9	8.1
Jacq. Ma. 2004	25.1	26.8	27.0	12.6
Ramos	25.6	23.9	25.9	11.5
Ravel	27.2	20.5	29.2	13.9
Gynlim	27.7	23.8	28.6	11.9
Cipres	28.0	23.5	30.6	14.8
Andreas	28.1	27.6	28.7	14.6
Eposs	28.4	22.3	30.2	9.6
JWC-1=ASP1	29.0	25.2	29.6	13.3
Ariane	29.1	27.7	29.8	10.1
Taramea	29.7	22.6	31.5	14.4
Trigal	30.0	24.6	30.5	13.6
Abril	31.2	25.2	34.2	11.6
Ramada	32.3	29.5	31.1	13.7
Tainan 2	33.9	26.6	35.7	12.4
Fileas	34.0	29.0	36.2	13.4
Sartaguda	34.4	31.3	39.2	12.3
PLA-P2232	38.2	31.5	37.9	12.6
Jacq. Ma. 2014	38.9	28.2	38.9	30.8
Tainan 3	39.3	33.4	37.9	11.3
Diego	40.5	29.3	42.8	15.8
Purple Passion	41.2	44.6	44.1	21.4
Tsuki-kho 3	54.0	40.7	59.1	24.1
Gloria	64.6	64.0	71.6	26.7
PLA-2132	83.3	65.1	87.5	29.4

The highest spear thickness uniformity was recorded in 'Ariane', 'Sartaguda' and 'Taramea' and the lowest in 'Jacq. Ma. 2014', 'Gloria' and 'Jacq. Ma. 2004' (Table 3).

Table 3. Spear diameter variability of 28 asparagus cultivars in years 2005, 2007 and 2008

Cultivar	Coefficient of variability of mean spear diameter (%)			
	2005	2007	2008	Mean
Ariane	24.5	20.1	22.4	22.8
Sartaguda	25.1	22.1	20.9	22.8
Taramea	22.4	23.1	24.2	23.3
Hannibal	27.9	25.0	21.1	24.6
Ramos	24.8	25.6	24.6	24.9
Andreas	23.4	25.3	26.8	25.1
Gynlim	25.0	23.9	27.0	25.6
Ramada	28.0	22.1	25.4	25.8
Ravel	29.6	22.7	25.4	26.5
Alpha	33.2	22.5	23.0	27.0
PLA-2132	31.5	23.4	25.9	27.6
JWC-1=ASP1	27.5	30.7	27.9	28.3
Cipres	32.6	32.2	22.6	28.5
Tainan 3	31.6	26.5	26.6	28.5
Eposs	34.5	25.4	25.3	29.0
Abril	31.9	24.4	29.5	29.4
PLA-P2232	33.7	28.8	25.4	29.4
Fileas	33.1	23.4	29.0	29.5
Tsuki-kho 3	24.2	37.1	31.4	29.7
Trigal	27.5	27.6	34.0	30.1
Tainan 2	33.0	25.8	30.2	30.4
Diego	37.6	22.6	28.7	31.0
Aarslev 270	35.4	29.3	30.5	32.2
Purple Passion	30.3	30.4	35.8	32.5
Grolim	39.4	30.1	29.3	33.5
Jacq. Ma. 2004	39.3	33.7	31.9	35.2
Gloria	39.8	30.9	-	35.3 *
Jacq. Ma. 2014	33.4	33.7	54.8	42.0

* - from two years

CONCLUSIONS

1. Variability of the examined cultivars was higher from the point of view of total and marketable yield expressed by the weight of harvested spears and smaller with regard to mean spear weight and total yield expressed by the number of harvested spears and plant survival.
2. Dutch and German cultivars were characterised by higher consistency of the total and marketable yields as well as mean spear weight in comparison with 28 cultivars.

3. Plant survival of Dutch and German cultivars was higher than the survival of 28 cultivars.
4. Cultivars with the smallest yields were also characterised by the worst yield consistency between harvest years.
5. The highest spear thickness uniformity was recorded in ‘Ariane’, ‘Sartaguda’ and ‘Taramea’ and the lowest - in ‘Jacq. Ma. 2014’, ‘Gloria’ and ‘Jacq. Ma. 2004’.

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ZMIENNOŚĆ CECH UŻYTKOWYCH 28 ODMIAN SZPARAGA (*Asparagus officinalis* L.)

Streszczenie

Doświadczenie, którego celem było scharakteryzowanie zmienności cech użytkowych 28 odmian szparaga w uprawie na zielone wypustki przeprowadzono w Katedrze Warzywnictwa Uniwersytetu Przyrodniczego w Poznaniu w latach 2004-2008. Określono zmienność pod względem wielkości plonu ogólnego, handlowego, średniej masy wypustki i przeżywalności roślin dla 28 odmian łącznie oraz osobno dla odmian niemieckich i holenderskich. Ponadto scharakteryzowano zmienność między latami zbiorów u poszczególnych odmian dla wielkości plonu ogólnego, handlowego i średniej masy wypustki w pięciu oraz grubości wypustek w trzech wybranych latach zbioru.

Stwierdzono większe zróżnicowanie odmian pod względem plonu handlowego i ogólnego wyrażonego masą zebranych wypustek a mniejsze pod względem średniej masy wypustki i plonu ogólnego wyrażonego liczbą zebranych wypustek. Odmiany mniej plenne miały najmniej wyrównany plon między poszczególnymi latami zbioru i najmniejszą przeżywalność roślin. Większe wyrównanie plonu, średniej masy wypustki i przeżywalności było u grupy odmian niemieckich i holenderskich.