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Evaluation of biological characteristics and productivity
of asparagus (*Asparagus officinalis* L.)

ABSTRACT. The productivity of asparagus male and female plants of standard cultivars, i.e. Mary Washington, D'Argenteuili hative and Viking, was investigated in the period of 2000–2002. The research on the intensity of shoots formation, resprouting the asparagus bushes in the period of winter, was carried out. It was found that the productivity of asparagus depends on the genetic characteristics of the cultivar, gender of the plant and meteorological conditions. The most productive variety of asparagus is Mary Washington. The highest yield of shoots is received from the male plants of this cultivar. However, the marketable quality of female plants' shoots is higher. All the standard cultivar are suitable for resprouting in the period of winter. The biochemical composition of asparagus shoots depends on the characteristics of the cultivar.

KEY WORDS: asparagus, cultivars, winter forcing, yield components, chemical composition

Asparagus (*Asparagus officinalis* L.) plants are grown as delicate vegetables in many countries. The shoots of asparagus are valued in Germany, the USA, France, Spain, Italy, and Taiwan. Asparagus is grown only as a decorative plant in the flower gardens in Lithuania, since their shoots are very suitable for bouquets [Mantred 1982; Svetika, Kmitiene 1983].

Asparagus is a perennial rootstock plant, which has thick, branchy bush, i.e. rootstock with thick rope-like roots. There are buds at the top of the bush and they develop into thick, juicy, edible shoots. The bush of adult asparagus can yield up to 50 shoots. The shoots are white in the soil, and when their tops ap-

pear in the surface of soil, they get the purplish, dark violet or green color. Uncut shoots develop into branchy stalks [Majlert 1969; Knaflewski 1995]. Asparagus is a dioecious plant: their male and female blossoms are formed on the separate plants. Usually, the crops of standard cultivars (Mary Washington, Lucullus, Limbros, Jersey Queen and etc.) contain the same amount of female and male plants. The male plants yield more shoots but they are harsh and tasteless. Female plants yield fewer shoots, but they are more tasty, sweeter and juicier [Girenko 1986; Knaflewski 1995].

The yield of asparagus is harvested in the second or the third year of their vegetation. The shoots are picked at the end of April or at the beginning of May and are picked for 5–6 weeks. Larger shoots are cut for consumption, and the smaller ones are left to form the terraneous part of asparagus [Kmitiene, Kmitas 1999]. According to the data of Knaflewski's [Knaflewski 1995] research, 10–15 year-old plants form the highest shoots yield; later, the yield decreases. The wide and various literatures on the growing of vegetables is provided, however, there is less practical knowledge of biological characteristics, nutritious value and agricultural engineering of asparagus cultivars.

The aim of the research is to study the biological and economical characteristics of the standard cultivars of asparagus and establish the productivity of male and female plants, as well as the intensity of the yield formation and its quality, resprouting in the period of winter.

METHODS

Research in the Department of Horticulture, Lithuanian University of Agriculture has been carried out since 1988. The biological characteristics, productivity and shoots' biochemical composition of asparagus cultivars Mary Washington and Viking were investigated.

In the period of 2000–2002, the productivity of male and female plants of standard cultivars, i.e. Mary Washington, D'Argenteuili hative and Viking, was investigated. In the period of 2000–2003, the research on the intensity of asparagus shoots formation, resprouting in the period of winter, was carried out in the research laboratory of the Department of Horticulture. The experiment of asparagus was set up in many rows with 4 repetitions. The fields in repetitions were located systematically. The size of a sample field was 8.0 m². The same methodology of field experiment was applied to all asparagus cultivars.

The strongest 3-year plants of Mary Washington and D'Argenteuili hative cultivars were selected for the stepped-up vegetation (resprouting in the period of winter) in autumn. Asparagus was dug out in October. The bushes were stored

in the cellar at the temperature of 0–2°C till the beginning of sprouting (in November).

The resprouting of asparagus starts when the bushes are brought in the room. The temperature during the resprouting was raised gradually: it was from 10–13°C to 15–18°C. The bushes were watered with the water of indoor temperature; the room was ventilated. The shoots of standard length (15–20 cm) were cut every third or fourth day. They were cut 7–10 times during the whole period of resprouting. During the period of asparagus vegetation, the phenological phases were studied, the biometric measurements were carried out, the biochemical composition and the productivity were determined. The chemical composition of asparagus shoots in the raw of natural humidity was determined under standard methodology for substances determination in the Agrochemical Research Laboratory of the Experimentation Station of Lithuanian University of Agriculture. The amount of dry substances was determined, exsiccating samples to the constant mass at the temperature of 105°C. The amount of vitamin C (ascorbic acid) was determined under the Murri method of titrating and the amount of nitrates was determined under the ionometric method.

RESULTS

All the studied varieties were grown under the same conditions; however, the plants of Mary Washington cultivar yielded the largest total crop of shoots, i.e. 3.7 t ha⁻¹, the average yield of male plants was also the highest one (Tab. 1). D'Argenteuili hative plants yielded the smallest crop, i.e. 2.4 t ha⁻¹ on average. The shoots yield of male plants of all cultivars was higher than that of female plants. The largest shoots crop from a single plant was yielded by Mary Washington cultivar's and the lowest yield was received from the plant of D'Argenteuili hative cultivar's.

Table 1. Shoots productivity of male and female plants of different garden asparagus cultivars

Cultivars	Shoots yield t ha ⁻¹			Shoots yield per plant g	
	total	male plant	female plant	male plant	female plant
Mary Washington	3.7	2.0	1.7	274.0	240.0
D'Argenteuili hative	2.4	1.5	0.9	175.0	115.0
Viking	2.6	1.5	1.1	176.0	151.0
LSD _{0.05}	0.7	0.3	0.2	26.8	16.0

The shoots' quality rates of male and female plants depended on the characteristics of the cultivar and gender of the plant (Tab. 2). The male plants of Mary Washington cultivar yielded the largest shoots (their average mass reached 31.2 g). The bushes of D'Argenteuili hative cultivar yielded the largest number of shoots (i.e. 13.8 male plants and 12.2 female plants) on average; however, their average mass was the smallest one.

Male plants formed shorter shoots (14.8–15.7 cm), but their diameter was wider, i.e. 1.5–2.1 cm. The female plants of Viking cultivar formed the shoots of the highest quality: their average length reached 16.6 cm and the diameter was 2.0 cm; however, they formed the smallest number of shoots in their bushes.

Table 2. Parameters of shoots quality of different garden asparagus cultivars

Cultivars	Shoots number per plant		Shoot mass g		Shoot height cm		Shoot diameter cm	
	male plant	female plant	male plant	female plant	male plant	female plant	male plant	female plant
Mary Washington	9.6	9.4	31.2	30.9	15.7	16.6	1.9	1.8
D'Argenteuili hative	13.8	12.1	16.6	16.2	14.8	15.0	1.5	1.3
Viking	10.0	7.6	27.4	27.1	15.5	16.6	2.1	2.0
LSD _{0.05}	1.2	0.7	1.5	1.8	0.8	0.7	0.2	0.4

The biochemical composition of male plants' shoots and female plants' shoots differed slightly (Tab. 3). The largest amount of dry substances (in male plants and in female plants) and vitamin C (in male plants and in female plants) was stored in the shoots of Viking cultivar. They shoots stored the smallest amount of nitrates.

The bushes of two asparagus cultivars – Mary Washington and D'Argenteuili hative – were resprouted. The bushes of Mary Washington cultivar resprout faster. The first yield was harvested on the 35th day after the beginning of resprouting. The yield of D'Argenteuili hative cultivar was received on the 47th day.

Table 3. Biochemical composition of different garden asparagus cultivars

Cultivars	Dry matter %		Vitamin C mg kg ⁻¹		Nitrates mg kg ⁻¹	
	male plant	female plant	male plant	female plant	male plant	female plant
Mary Washington	9.40	8.96	189.0	187.9	280.0	244.0
D'Argenteuili hative	8.70	9.10	192.0	194.8	268.0	256.0
Viking	10.20	9.75	207.5	209.0	192.0	185.0
LSD _{0.05}	1.3	0.6	0.9	1.3	27.1	49.6

The duration of the harvest time of this cultivar reached approximately 62 days (20 days more than that of Mary Washington cultivar). The higher yield of shoots was received from the bushes of D'Argenteuili hative cultivar (Tab. 4). The standard shoots accounted for 96.2% of the total yield. The bushes of Mary Washington formed more nonstandard shoots.

Table 4. Forcing shoots productivity of garden asparagus

Cultivars	Total shoots yield kg m ⁻²	Standard shoots		Non-standard shoots	
		kg m ⁻²	% of total yield	kg m ⁻²	% of total yield
Mary Washington	1.04	1.01	93.0	0.03	6.90
D'Argenteuili hative	1.59	1.56	96.2	0.04	3.80
LSD _{0.05}	0.52	0.64	-	0.04	-

The larger amount of shoots was received from the bushes of D'Argenteuili hative cultivar and the average mass of shoots reached 22.6 g (Tab. 5). The shoots of this cultivar were longer and thicker.

The resprouted shoots of Mary Washington cultivar stored more dry substances in comparison with the D'Argenteuili hative cultivar, i.e. 9.40% on average (Tab. 6).

Table 5. Forcing shoots quality parameters of garden asparagus

Cultivars	Shoots number per plant	Shoot mass g	Shoot height cm	Shoot diameter cm
Mary Washington	14.0	17.6	15.6	2.0
D'Argenteuili hative	18.0	22.6	19.7	2.4
LSD _{0.05}	3.0	1.5	2.5	0.3

Table 6. Forcing shoots in winter biochemical compositions

Cultivars	Dry matte %	Soluble dry matter %	Vitamin C mg kg ⁻¹	Nitrates mg kg ⁻¹
Mary Washington	9.40	7.85	87.9	80.7
D'Argenteuili hative	6.22	8.25	108.0	87.8
LSD _{0.05}	2.62	1.04	0.7	29.2

However, the shoots of D'Argenteuili hative cultivar stored more soluble dry substances and vitamin C. The amount of nitrate nitrogen in the resprouted asparagus shoots was negligible.

CONCLUSIONS

1. The productivity of asparagus depends on the genetic characteristics of the cultivar, the age of bush, gender of plant and meteorological conditions.
2. The highest yield of shoots is received from the male plants of Mary Washinton cultivar, i.e. approximately 51.6% of the total yield. The marketable quality of female plants' shoots is higher.
3. All the standard varieties are suitable for the resprouting in the period of winter. The longer harvest time and higher yield is received from the bushes of D'Argenteuili hative cultivar.
4. The largest amount of nutrients is stored in the shoots of the cultivars Mary Washington (grown outside) and D'Argenteuili hative (resprouted in the period of winter).

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