THE EFFECT OF VARIOUS SOIL MANAGEMENT TECHNIQUES ON GROWTH AND YIELD IN THE BLACK CHOKEBERRY (*Aronia melanocarpa* Elliot)

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A B S T R A C T

The aim of this study was to determine the effect of several soil management techniques on development, growth and yield in black chokeberry bushes growing in the province of Warmia and Mazuria in Poland. In 1991, black chokeberry bushes were planted at the Experimental Gardens of the University of Warmia and Mazuria in Olsztyn. Starting in 1992, the following soil maintenance procedures were carried out: hand weeding; mulching with conifer bark; mulching with aged manure; mulching with black sheet plastic; and spraying with Gesatop 50 WP. Hand weeding was carried out whenever weeds appeared. The conifer bark and manure mulches were replenished every three years. The black sheet plastic was replaced every other year. Gesatop 50 WP was applied every year in April. Data were collected from 2001 to 2005. The data collected included start of vegetative growth, blossoming dates, optimal harvest date, bush height, bush diameter, number of first-year shoots, length of first-year shoots, diameter of first-year shoots, number of blossoms per cluster, number of berries per cluster, mass of 100 berries, and yield per bush. The start of vegetative growth, blossoming dates and optimum harvest date varied considerably from year to year, depending on weather conditions. In Warmia and Mazuria, the dates can vary by as much as thirty days. Vegetative growth was most intense in bushes mulched with either conifer bark or aged manure, and least intense in bushes mulched with black sheet plastic. Five-year cumulative yield was highest in bushes mulched with either conifer bark or aged manure, and lowest in bushes either weeded by hand or mulched with black sheet plastic.

Key words: black chokeberries, developmental stages, soil management, growth, yield

INTRODUCTION

Black chokeberries are highly valued by the fruit processing industry, which uses them mainly in juice production. Black chokeberry bushes grow and yield well all over Poland (Chlebowska et al., 1994; Gwozdecki,

2003). In the province of Warmia and Mazuria, yields are as high as in other parts of Poland (Kawecki and Kozłowski, 1992).

The aim of this study was to determine the effect of several soil management techniques on development, growth and yield in black chokeberry bushes growing in Warmia and Mazuria.

MATERIAL AND METHODS

The study was carried out at the Experimental Gardens of the University of Warmia and Mazuria in Olsztyn.

In 1991, black chokeberry bushes were planted 2 x 3 meters apart in Class IVa soil. The bushes had been propagated vegetatively.

Starting in 1992, the following soil management techniques were carried out along the rows:

- hand weeding;
- mulching with 15 cm of conifer bark;
- mulching with 15 cm of aged manure;
- mulching with black sheet plastic;
- spraying with Gesatop 50 WP (3 kg/ha).

Hand weeding was carried out whenever weeds appeared. The conifer bark and manure mulches were replenished every three years. The black sheet plastic was replaced every other year. Gesatop 50 WP was applied every year in April.

The spaces between the rows were maintained as bare fallow with weeding hoes. The experiment was carried out in a randomized block design, with three replications of three bushes for each of the techniques tested.

Data were collected from 2001 and 2005. The data collected included start of vegetative growth, blossoming dates, optimal harvest date, bush height, bush diameter, number of 1-year-old shoots, length of 1-year-old shoots, diameter of 1-year-old shoots, number of blossoms per cluster, number of berries per cluster, mass of 100 berries, and yield per bush.

All data were statistically elaborated using analysis of variance, followed by means separation using Duncan's multiple-range t-test for a two-factorial experiment at $P \leq 0.05$. Calculations were carried out using the Statistica 6.0 software package.

RESULTS AND DISCUSSION

The start of vegetative growth, blossoming dates and optimal harvest date were not significantly affected by the choice of soil management technique. On the other hand, they did vary considerably from year to year.

The start of vegetative growth ranged from March 7 in 2002 to April 12 in 2003. Blossoming dates were also earliest in 2002 and latest in 2003. Optimal harvest date ranged from August 28 in 2002 to September 30 in 2001. Optimal harvest date was earlier in warm, sunny years (Tab. 1).

Table 1. Start of vegetative growth, blossoming dates and optimum harvest date in black chokeberry bushes growing in Warmia and Mazuria

Year	Start of vegetative growth	Blossoming			Harvest
		beginning	peak	end	
2001	March 12	April 19	May 5	May12	Sept. 30
2002	March 7	April 11	April 29	May 7	Aug. 28
2003	April 12	May 14	May 27	June 12	Sept. 18
2004	March 19	April 29	May 10	May 19	Sept. 28
2005	April 2	May 7	May 13	June 2	Sept. 06

The dates for the different developmental stages observed in this study agree well with earlier studies on black chokeberries growing in Warmia and Mazuria in which the dates varied by a few weeks from year to year (Kawecki and Kozłowski, 1992; Kawecki, 1999; Tomaszewska, 1999).

Spring temperatures were the main factor affecting the start of vegetative growth and the blossoming dates. Cool temperatures in early spring can delay the start of vegetative growth, the blossoming dates and, to some degree, the optimum harvest date (Petrowa, 1987).

Plant growth was affected by the choice of soil management technique. Plant growth also varied from year to year. In each year of the study, growth was most intense in the bushes mulched with manure, and least intense in the bushes mulched with black sheet plastic. In early spring, 2003, all of the bushes were pruned back harder than usual. This explains the lower values for bush height and diameter reported for that year (Tab. 2).

Vegetative growth in black chokeberry bushes was also affected by the choice of soil management technique. Growth was most intense in bushes mulched with either conifer bark or aged manure, and least intense in bushes mulched with black sheet plastic. This agrees well with a previous study, in which growth was most intense in bushes mulched with manure (Kawecki, 1999).

In another study on chokeberry bushes growing in Warmia and Mazuria, plant growth was most intense in bushes mulched with conifer bark and aged manure, although the number of fruits per cluster and the yield were low (Kawecki i Kozłowski, 1992).

The number of first-year shoots was not significantly affected by the choice of soil management technique. On the other hand, it did vary considerably from year to year. The highest numbers were generally recorded in 2005, and the lowest numbers in 2003. In a previous study, the number of first-year shoots was highest in bushes mulched with manure (Kawecki, 1999).

Table 2. Soil management technique and vegetative growth parameters in black chokeberry bushes growing in Warmia and Mazuria

Soil management technique	Year	Bush height [cm]	Bush diameter [cm]	First-year shoots		
				number	length [cm]	diameter [mm]
Hand weeding	2001	127	170	11.0	9	4.0
	2002	189	200	16.3	82	3.7
	2003	140	114	8.6	122	3.6
	2004	150	181	10.0	156	3.0
	2005	211	204	25.3	92	4.0
	mean	**163**	**174**	**14.2**	**102**	**3.7**
Conifer bark	2001	139	178	13.3	54	4.0
	2002	190	187	20.6	100	3.3
	2003	140	114	6.9	108	3.8
	2004	166	133	10.5	100	3.3
	2005	200	206	19.7	100	3.8
	mean	**167**	**164**	**14.2**	**92**	**3.7**
Aged manure	2001	146	193	16.0	86	4.0
	2002	195	206	10.5	110	3.2
	2003	164	194	7.9	110	2.2
	2004	184	200	17.0	92	3.5
	2005	208	209	22.3	99	3.8
	mean	**179**	**200**	**14.8**	**91**	**3.5**
Black sheet plastic	2001	123	163	9.7	42	3.8
	2002	144	186	11.2	86	3.6
	2003	113	113	6.2	132	3.7
	2004	133	143	15.6	102	3.2
	2005	200	117	20.3	95	3.7
	mean	**143**	**144**	**12.6**	**91**	**3.6**
Gesatop 50 WP	2001	128	192	13.3	52	3.7
	2002	146	158	12.0	97	3.5
	2003	132	142	6.8	140	3.6
	2004	172	188	9.8	100	3.3
	2005	197	202	17.3	98	3.8
	mean	**155**	**176**	**11.9**	**97**	**3.6**
$LSD_{Technique}$ (5%)		**20.56**	**1.06**	**3.80**	**20.47**	**0.37**
LSD_{Year} (5%)		**11.64**	**19.04**	**2.04**	**9.74**	**0.29**
$LSD_{Technique\ x\ year}$ (5%)		**1.05**	**1.89**	**n.s.**	**n.s.**	**0.20**

In the present study, the number of blossoms per cluster and the number of berries per cluster were highest in bushes mulched with black sheet plastic, and lowest in bushes mulched with conifer bark. The number of blossoms per cluster, the number of berries per cluster, and the mass of 100 berries all varied considerably from year to year (Tab. 3).

T a b l e 3 . Black chokeberry yield

Soil management technique	Year	Number of blossoms per cluster	Number of berries per cluster	Mass of 100 berries [g]	Yield [kg/bush]
Hand weeding	2001	17.7	15.3	89	9.7
	2002	18.1	14.0	92	15.5
	2003	14.0	13.0	98	13.8
	2004	14.0	11.0	98	10.0
	2005	16.2	10.5	84	8.0
	mean	**16.0**	**12.8**	**92**	**11.4**
Conifer bark	2001	16.3	13.0	85	10.8
	2002	18.3	16.7	80	14.8
	2003	14.3	12.2	90	18.2
	2004	11.3	10.2	89	19.9
	2005	18.3	11.1	82	6.8
	mean	**15.7**	**12.4**	**85**	**14.1**
Aged manure	2001	17.3	16.3	84	17.8
	2002	16.6	15.1	86	15.6
	2003	16.3	13.3	82	17.1
	2004	14.3	11.5	83	9.1
	2005	17.1	10.2	81	8.8
	mean	**16.3**	**13.0**	**83**	**13.7**
Black sheet plastic	2001	18.0	17.0	80	10.4
	2002	18.3	16.7	78	14.4
	2003	17.3	14.2	85	13.4
	2004	17.0	13.3	77	10.2
	2005	15.2	9.4	81	5.1
	mean	**17.2**	**14.1**	**80**	**10.7**
Gesatop 50 WP	2001	16.3	15.3	91	13.0
	2002	16.7	14.4	90	14.1
	2003	16.7	14.8	107	15.8
	2004	16.7	11.5	97	10.3
	2005	14.8	9.1	79	5.2
	mean	**16.2**	**13.0**	**93**	**11.7**
LSD $_{Technique}$ (5%)		**0.008**	**0.083**	**3**	**2.83**
LSD $_{Year}$ (5%)		**0.008**	**0.083**	**5**	**1.87**
LSD $_{Technique\ x\ year}$ (5%)		**0.019**	**0.186**	**n.s.**	**n.s.**

Yield was highest in the bushes mulched with either conifer bark or aged manure, and lowest in the bushes either weeded by hand or mulched with black sheet plastic. In a previous study, yield was highest in bushes either sprayed with Gesatop 50 WP or mulched with black sheet plastic (Kawecki, 1999).

Mulching with manure has been reported to over-stimulate vegetative growth without increasing yield.

Furthermore, manure is relatively expensive and does not provide adequate weed control. Hand weeding is too labor intensive and expensive.

Black chokeberries do not require high doses of nitrogen fertilizer. In a previous study, doses over 50 kg/ha increased vegetative growth, but actually reduced yield (Chlebowska et al., 1994).

In another study, yield and fruit quality were not significantly affected by the choice of soil management technique. They were, however, strongly affected by weather conditions during the growing season. Yield and fruit quality were lowest in years with very dry summers (Pietrowa, 1987).

CONCLUSIONS

The start of vegetative growth, blossoming dates and optimum harvest date varied considerably from year to year, depending on weather conditions. In black chokeberry bushes growing in Warmia and Mazuria, the dates can vary by as many as thirty days.

Vegetative growth was most intense in bushes mulched with either conifer bark or aged manure, and least intense in bushes mulched with black sheet plastic.

Five-year cumulative yield was highest in bushes mulched with either conifer bark or aged manure, and lowest in bushes either weeded by hand or mulched with black sheet plastic.

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WZROST I PLONOWANIE KRZEWÓW ARONII PRZY RÓŻNYCH SPOSOBACH PIELĘGNACJI GLEBY

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S T R E S Z C Z E N I E

Celem badań było określenie wpływu kilku sposobów pielęgnacji gleby w rzędach krzewów aronii na ich wzrost i plonowanie. W latach 2000-2005 przeprowadzono badania na 10-15-letnich krzewach uprawianych rzędowo 3 x 2 m pod zbiór ręczny w warunkach klimatyczno-glebowych Olsztyna. Zastosowano różne sposoby pielęgnacji gleby w rzędach – odchwaszczanie ręczne, ściółkowanie korą z drzew iglastych (15 cm), ściółkowanie przefermentowanym obornikiem, ściółkowanie czarną folią, opryskiwanie herbicydem Gesatop 50 WP wczesną wiosną (kwiecień) w dawce 3 kg/ha. Obornik i korę uzupełniano co 3 lata, czarną folię co 2 lata. Glebę w międzyrzędziach utrzymywano w czarnym ugorze, usuwając pojawiające się chwasty motyką.

W okresie 5-letnich badań wykazano, że w warunkach Warmii i Mazur fazy rozwojowe roślin w poszczególnych latach są znacznie przesunięte w czasie, a zróżnicowanie w czasie rozpoczęcia wegetacji między latami wynosi nawet powyżej 30 dni. Ściółkowanie obornikiem i korą z drzew iglastych spowodowało intensywniejszy wzrost krzewów i wyższe plonowanie w porównaniu do ściółkowania gleby czarną folią i do odchwaszczania ręcznego, a także po zastosowaniu herbicydu Gesatop 50 WP.

Słowa kluczowe: aronia, fazy rozwojowe, utrzymanie gleby, wzrost, plonowanie