

Off-season Production of Southern Highbush Blueberries in the North of Spain

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Keywords: *Vaccinium corymbosum*, blossom, yield, fruit size, plastic greenhouse

Abstract

Asturias in Northern Spain has suitable soil and climatic conditions and is adequate for growing soft fruits. Considering the new European market trends, off-season production of cane and bush fruits seems to be an interesting and profitable way of diversifying the alternatives for the agrarian sector. So, the aim of this work was to evaluate the agronomic behaviour of Southern highbush blueberry cultivars (*Vaccinium corymbosum*) grown in trenches and under Italian-type tunnels, without heat. Research was started in March 1998 at an experimental farm in Villaviciosa-Asturias (5°26'W, 43°28'N), Northern Spain, with two-year-old Southern highbush blueberry plants. Six cultivars were included in the study: 'Avonblue', 'Flordablue', 'Misty', 'Reveille', 'Sharpblue' and 'Sunshineblue'. They were planted at 0.75 x 2.0 m. Trenches were filled in with acid peat and pine bark (1:1). The first yield was harvested in 2000, with 'Flordablue', 'Misty' and 'Sharpblue' producing more than 1750 g plant⁻¹. For the average marketable yield over three years, 'Sharpblue' produced 2061 g plant⁻¹. Ripening of fruit started in the middle of May, berry weight decreased for all the cultivars as the picking period progressed. This trial shows that it is possible to grow Southern highbush blueberry cultivars under plastic and achieve good yields before those obtained in the open field. The cultivar 'Reveille' must be avoided because of both its low productive potential and small fruit size for the fresh market.

INTRODUCTION

Asturias in Northern Spain has suitable soil and climatic conditions for growing soft fruits. The culture of these berries provides an interesting alternative for improving the profitability of small family farms; is favourable to the rural population as well as incorporates young people into the sector (Ciordia et al., 1994). It is also well suited to the extreme parcelling of land and the reduced dimensions of growing units due to the orographical characteristics, in a similar way observed in the mountain area of the Province of Trento in Northern Italy (Da Via and Monfredini, 1993). The growing of soft fruits has a great social interest due to two main reasons: it is very demanding in terms of labour and high profits can be obtained.

Of all the soft fruits, the highbush blueberry has produced the most interest among people. This culture also allows the use of land which as a result of its high acidity is not suitable for other crops. Nevertheless, many growers have to reject the idea of establishing a plantation if the acidity of the soil is inadequate. This problem of high pH was also present in the experimental field of the SERIDA, so the trial was conducted in trenches filled in with acid peat and pine bark in order to avoid this problem.

Off-season production of cane and bush fruits seems to be an interesting and profitable way to expand the fruiting period and to diversify the alternatives for the agrarian sector. Trials to improve off-season production by growing blueberries in greenhouses, tunnels and under raincovers have been done (Ishikawa and Sugawara, 1993, Bal 1997, Fernández and Ballington, 2004). A previous research study growing two Northern highbush blueberries varieties, 'Bluetta' and 'Duke' and a Southern highbush

one, 'Sharpblue' both in pots and under Italian-type tunnels was done in Asturias (Ciordia et al., 2002). Plastic tunnels were used to produce an earlier harvest period and to allow the diversification of this site, acquired by horticultural growers to proceed with the expansion of berry crops, as these cultivars are not traditional in Asturias. The aim of this work was to evaluate the off-season agronomic behaviour of Southern highbush blueberry cultivars for the fresh market.

MATERIALS AND METHODS

Research plots were established on an experimental farm in Villaviciosa, Asturias (5°26'W, 43°28'N) in Northern Spain, by the end of March, 1998. Six Southern highbush blueberries varieties were included in the study: 'Avonblue', 'Flordablue', 'Misty', 'Reveille', 'Sharpblue' and 'Sunshineblue'. Two-year-old plants were planted under one of the Italian-type multitunnels, with a metallic frame, 4 m in width and 42 m in length, in trenches of 50 cm in width and 30 cm in depth filled in with acid peat and pine bark (1:1), pH 4. Planting distance was 0.75 m x 2 m giving a high density of 6600 plants ha⁻¹. The plastic cover from the tunnel was of the thermal type, with three layers, and a thickness of 200 µm. The tunnel was also provided with a drip irrigation system. Flowers were stripped from the plants until the 2000 season. Fertilization from 1998 to 2002 is shown in Table 1. Microelements were included in the fertilizers. With respect to pests, it was necessary to reduce aphids every year and scales, only in 2002, with pesticides.

A randomized block design with four replicates was established. Four plants formed the experimental unit. Data were collected individually from the two central plants of each block, in order to minimize interactions among blocks. Phenological observations were recorded, starting at the beginning of flowering when 5% of the flowers were open. Fruit were picked when they attained a dark blue colour, and picking dates were recorded. The initial ripening date was considered when at least 5% of the berries were picked, and final when the 90% of the fruit had been harvested. For each block and date, fruit were separated in the laboratory into two categories, marketable and non-marketable, fruit with physical damage being included in the latter, and each one was weighed. After this, fifty fruit from the marketable category were randomly selected and weighed, in order to calculate mean berry weight.

Quantitative data were analyzed by ANOVA (SPSS Inc. Win version 10.0) after verification of variance homogeneity with the Levene test. Mean separation using Student-Newman-Keuls and Scheffé tests were performed a posteriori.

RESULTS AND DISCUSSION

Rabbiteye and Southern highbush blueberry varieties require a shorter rest period than do Northern highbush cultivars (Eck et al., 1990). As many authors indicated, additional chilling above the required number of hours to break dormancy increases the amount and rate of floral bud break (Gilreath and Buchanan, 1981; Spiers and Draper, 1974). In Asturias, chilling hours below 7°C exceeded the requirements of these tetraploid plants to break dormancy (data not shown).

Vegetative development of the plants was limited until 2000, contrasting with the high number of flowers. This was due probably to the excess of rainfall filtering between tunnels, as plants started to improve after a drainage ditch was made. Flowering started in February 4th with 'Misty', followed by 'Sharpblue' the 10th. All the varieties required from 81 to 106 days to mature (Table 2), more than those required by the Northern highbush cultivars 'Bluetta' and 'Duke' cultivated in pots and under plastic tunnels (Ciordia et al., 2002).

The ripening period is one of the most important factors in the selection of cultivars, especially when they are cultivated under plastic, considering both the investments in plants and facilities, and the high off-season price for the fresh market in Europe. No blueberries ripen in Northern Spain from the middle of May until the end of June as in Huelva, Southern Spain ripening extends from March to May (R. Aguilar, personal communication). In this trial, the harvesting started at the middle of May, with

'Flordablue', about ten days before harvesting under protection begins with the early Northern highbush cultivars in Asturias. Ripening period concentrated in June when all the cultivars were at the peak of harvest; and it concluded in July as the different cultivars matured (Table 2).

The first crop was obtained in 2000. All the cultivars produced a marketable crop greater than 1000 g plant⁻¹ every year. There were outliers; 'Sharpblue' with 2061.38 g plant⁻¹ and 'Reveille' with the least significant ($p < 0.05$) yield at only 784.44 g plant⁻¹ for the average marketable yield from 2000 to 2002 (Table 3). For all the cultivars in the study, non-marketable fruit was very low and due to bird damage. Considering the value of the initial picking all cultivars, with the exception of 'Reveille', presented a good berry weight, superior to those reported previously for 'Bluetta', 'Duke' and 'Sharpblue' (Ciordia et al., 2002). Mean fruit size was over a gram for all the cultivars, except for 'Reveille' (Table 4). Fruit weight decreased significantly with the final harvest in all cultivars, achieving in most of the cultivars values equal or less than one gram, that are not acceptable for the fresh market. 'Reveille' had the disadvantage of having the smallest berry size during all the ripening period, always less than one gram.

The ANOVA analysis allows us to observe significant differences among cultivars for the parameters studied through the different harvest seasons. Considering the average data, significant differences in total, marketable and non-marketable yield, as well as initial, final and average berry weight were found between cultivars and years (Tables 3, 4). The cultivar by year interaction only showed low significance in non-marketable yield, meaning that total and marketable yield of all cultivars for the three years was generally similar (Table 3). Important differences were found in the cultivar by year interaction in berry weight (Table 4).

In conclusion, harvesting starts with 'Flordablue' in the middle of May which is of interest to capture premium market niches, when high prices can be obtained. 'Avonblue', 'Flordablue', 'Misty', 'Sharpblue' and 'Sunshineblue' are cultivars well adapted to the culture under Italian-tunnels in Asturias, with the ripening period centred throughout June, and have a mean fruit size over a gram. 'Reveille' should be excluded in new commercial plantings because of both its poor yield and small berry size for the fresh market. This study will be continued and complemented with further studies analysing quality parameters of the fruit.

ACKNOWLEDGEMENTS

Thanks to Principado de Asturias for financial assistance and J. Majada and S. Pereira for their collaboration when needed.

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Tables

Table 1. Fertilizer program (kg ha⁻¹).

Year	N	P	K	Mg	S
1998	41	156	129	3	106
1999	123	19	18	5	4
2000	66	37	153	10	9
2001	82	49	128	5	27
2002	96	40	125	35	1

Table 2. Flowering time (average 2000-02), harvest and days between flowering and harvest of six Southern blueberry cultivars.

Cultivar	First flowering	Harvest			Days from first flowering to first harvest
		First	Half	End	
'Avonblue'	17-February	26-May	14-June	13-July	98
'Flordablue'	17-February	16-May	3-June	4-July	88
'Misty'	4-February	21-May	12-June	8-July	106
'Reveille'	11-March	31-May	17-June	5-July	81
'Sharpblue'	10-February	26-May	14-June	13-July	105
'Sunshineblue'	21-February	27-May	27-June	20-July	88

First flowering: 5% of flowers opened; First harvest : 5% of fruits picked, Half harvest: 50%, Final harvest: 90%.

Table 3. Total, marketable and non-marketable production (g/plant) of six Southern highbush varieties cultivated in trenches under a tunnel.

Cultivar	Year	Yield (g plant ⁻¹)		
		Total	Marketable	Non-marketable
'Avonblue'	2000	1367.34 a	1357.36 ab	9.98 ab
'Flordablue'	2000	1786.20 a	1774.03 a	12.18 ab
'Misty'	2000	1990.90 a	1983.04 a	7.86 b
'Reveille'	2000	411.36 b	410.11 b	1.25 b
'Sharpblue'	2000	1985.68 a	1961.90 a	23.78 a
'Sunshineblue'	2000	1334.30 a	1322.88 ab	11.43 ab
Probability ¹		0.002	0.002	0.008
'Avonblue'	2001	1694.49 ab	1694.49 ab	0.00
'Flordablue'	2001	1947.05 a	1947.05 a	0.00
'Misty'	2001	1946.45 a	1946.45 a	0.00
'Reveille'	2001	1098.39 b	1098.39 b	0.00
'Sharpblue'	2001	2023.20 a	2023.20 a	0.00
'Sunshineblue'	2001	1268.42 ab	1268.42 ab	0.00
Probability ¹		0.007	0.007	
'Avonblue'	2002	1293.94 b	1289.06 b	4.99 a
'Flordablue'	2002	1025.04 b	1017.31 b	7.94 a
'Misty'	2002	1314.74 b	1309.49 b	5.25 a
'Reveille'	2002	848.27 b	844.83 b	3.44 a
'Sharpblue'	2002	2203.46 a	2199.04 a	4.43 a
'Sunshineblue'	2002	993.85 b	988.50 b	5.35 a
Probability ¹		0.0001	0.0001	ns
	Average			
'Avonblue'	2000-02	1451.92 bc	1446.97 bc	4.99 ab
'Flordablue'	2000-02	1586.10 bc	1579.46 bc	6.71 ab
'Misty'	2000-02	1750.70 ab	1746.33 ab	4.37 ab
'Reveille'	2000-02	786.01d	784.44 c	1.56 b
'Sharpblue'	2000-02	2070.78 a	2061.38 a	9.40 a
'Sunshineblue'	2000-02	1212.40c	1206.22 b	6.17 ab
Probability ¹				
Cultivar		0.0001	0.0001	0.01
Year		0.016	0.014	0.0001
Cultivar x year		ns	ns	0.003

¹ Probability that no difference exists between samples. Values within columns followed by the same letter are not significantly different according to SNK's Test, 5% level.

Table 4. Berry weight (g) of six Southern highbush varieties cultivated in trenches under a tunnel.

Cultivar	Year	Berry weight (g)		
		Initial	Final	Average
'Avonblue'	2000	1.627 a A	1.004 a B	1.332 ab
'Flordablue'	2000	1.610 a A	1.169 a B	1.506 a
'Misty'	2000	1.595 a A	1.267 a B	1.475 a
'Reveille'	2000	0.851 b A	0.763 a A	0.941 c
'Sharpblue'	2000	1.749 a A	1.044 a B	1.501 a
'Sunshineblue'	2000	1.506 a A	0.954 a B	1.222 b
Probability ¹		0.0001	0.020	0.0001
'Avonblue'	2001	1.406 ab A	1.157 a A	1.318 a
'Flordablue'	2001	1.483 ab A	1.075 a B	1.294 a
'Misty'	2001	1.511 ab A	0.944 a B	1.291 a
'Reveille'	2001	0.759 c A	0.447 b B	0.648 b
'Sharpblue'	2001	1.317 b A	0.868 a B	1.207 a
'Sunshineblue'	2001	1.648 a A	0.902 a B	1.372 a
Probability ¹		0.0001	0.0001	0.0001
	Average			
'Avonblue'	2002	1.020 bc A	0.818 a B	0.984 bc
'Flordablue'	2002	1.416 ab A	0.962 a B	1.135 ab
'Misty'	2002	1.067 bc A	0.812 a B	0.972 bc
'Reveille'	2002	0.540 d A	0.403 b B	0.467 d
'Sharpblue'	2002	0.916 cd A	0.721 a A	0.911 c
'Sunshineblue'	2002	1.751 a A	0.934 a B	1.220 a
Probability ¹		0.0001	0.0001	0.0001
	Average			
'Avonblue'	2000-02	1.325 b A	1.000 a B	1.212 a
'Flordablue'	2000-02	1.511 ab A	1.064 a B	1.310 a
'Misty'	2000-02	1.421 ab A	1.019 a B	1.234 a
'Reveille'	2000-02	0.717 b A	0.505 b B	0.625 b
'Sharpblue'	2000-02	1.364 b A	0.876 a B	1.192 a
'Sunshineblue'	2000-02	1.599 a A	0.930 a B	1.272 a
Probability ¹				
Cultivar		0.0001	0.0001	0.0001
Year		0.0001	0.0001	0.0001
Cultivar x year		0.0001	0.0330	0.0001

¹ Probability that no difference exists between samples. For each column in small letters and for lines in capital, means followed by the same letter are not significantly different according to Scheffe's Test, 5% level.