

THE PERFORMANCE OF SOME NORTHERN Highbush BLUEBERRY
(*Vaccinium corymbosum* L.) VARIETIES IN NORTH EASTERN PART OF ANATOLIA

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ABSTRACT: This study was conducted to find out performance of some northern highbush blueberries in northeastern part of Turkey. Two years old plants of Berkeley, Ivanhoe, Jersey, Northland and Rekord blueberry (*Vaccinium corymbosum* L.) varieties planted in İkizdere, Rize. Their phenological, morphological and yield properties were determined. Among cultivars 'Ivanhoe' had the highest (146.44 cm) and most extremely vigor bushes. 'Berkeley' gave shorter plants with short bushes (82.72 cm) but had bigger (40.76 cm²) leaves. 'Ivanhoe' was the most productive (2567.80 g/plant) whereas 'Berkeley' had the lowest yield (455.21 g/plant). 'Ivanhoe' also had the largest berry (2.41g) while 'Northland' had the smallest (0.94g) ones. Cultivars begin to ripe in between 10 July ('Ivanhoe') and 25 July ('Jersey' and 'Northland'). Berries per cluster were the highest (54.74) for Jersey. Stem scar diameter was the biggest (2.19 mm) on 'Berkeley' berry while 'Northland' had smallest stem scar (1.46 mm) with small berries. Total soluble solids and titratable acid content were between 10.04% ('Northland')-11.00% ('Ivanhoe' and 'Jersey') and 0.96% ('Rekord')-1.59% ('Ivanhoe'), respectively. 'Ivanhoe', 'Berkeley' and 'Rekord' varieties with large or very large fruits should be consuming as fresh berry. 'Northland' had small fruits is well for industry while Jersey can be use both fresh and processing.

Key words: Highbush blueberry, *Vaccinium corymbosum* L., variety characteristics, Blacksea/Turkey.

BAZI YÜKSEK BOYLU MAVİYEMİŞ (*Vaccinium corymbosum* L.) ÇEŞİTLERİNİN KUZEYDOĞU
ANADOLU BÖLGESİNDEKİ PERFORMANSLARI

ÖZET: Bu çalışma ile dünyada kültürü yapılan yüksek boylu maviyemiş çeşitleri ile Doğu Karadeniz bölgesinde ilk kez 2002-2005 yılları arasında adaptasyon denemsi yapılmıştır. Bu amaçla kuzey orijinli yüksek boylu maviyemiş çeşitleri olan 'Berkeley', 'Ivanhoe', 'Jersey', 'Northland' ve 'Rekord' Rize'nin İkizdere ilçesinde denemeye alınmış, büyüme, gelişme, fenolojik ve morfolojik özellikleri ile verim ve bazı meyve özellikleri saptanmıştır. Denemeye alınan maviyemiş çeşitlerinin çoğu kuvvetli bir gelişme göstermesine rağmen en uzun sürgünler 146.44 cm ile 'Ivanhoe' çeşidinde ölçülmüştür. 'Berkeley' çeşidi 82.72 cm ile en kısa sürgünlere sahip çeşit iken bu çeşidin yaprakları 40.76 cm² ile diğerlerine göre çok daha büyük olmuştur. 'Ivanhoe' çeşidi en yüksek verimli (2567.80 g/bitki) çeşit olup 'Berkeley' çeşidi 455.21 g/bitki ile en düşük verimli çeşit olmuştur. Meyve iriliği 'Ivanhoe'da 2.41g ile en yüksek, 'Northland' çeşidinde ise 0.94g ile en düşük olmuştur. Sap çukuru yara izi ise 'Berkeley' çeşidinde en büyük (2.19 mm), 'Northland' çeşidinde ise en küçük (1.46 mm) olduğu saptanmıştır. Çeşitlerin kurumadde içerikleri ile toplam asitlik değerleri sırasıyla %10.04 ('Northland')-%11.00 ('Ivanhoe' ve 'Jersey') ile %0.96 ('Rekord') – %1.59 ('Ivanhoe') arasında değişmiştir. Çalışmaya göre 'Ivanhoe', 'Berkeley' ve 'Rekord' çeşitleri iri veya çok iri meyve vermeleri ile taze tüketime yönelik olarak yetiştirilebileceği; daha ince meyveli olan 'Northland' çeşidinin sanayide değerlendirilebileceği, 'jersey' çeşidinin ise hem taze tüketim hem de sanayilik olarak kullanıma uygun olduğu saptanmıştır.

Anahtar Sözcükler: Maviyemiş, *Vaccinium corymbosum* L., çeşit özellikleri, Karadeniz Bölgesi/Türkiye

1. INTRODUCTION

Blueberries are members of the *Ericaceae* or Heath family, genus *Vaccinium*, subgenus *Cyanococcus*. The genus is very diverse, containing between 150 and 450 species, mostly found in the tropics at high elevation, but also in temperate and boreal regions. Most are shrubs like the blueberries, but again, a range of growth forms from epiphytes to trees exists. The *Ericaceae* contains several important ornamentals, rhododendrons and azaleas (*Rhododendron*), mountain laurel (*Kalmia latifolia*), heather (*Calluna*), heath (*Erica*), and leather leaf (*Leucothoe*). Three commercially important blueberry species are recognized, Northern and Southern highbush blueberry (*Vaccinium corymbosum* L.) which native range is sunny, acidic, swampy areas of eastern North America, from Nova Scotia west to Wisconsin, south to northern Georgia. Rabbiteye blueberry (*Vaccinium ashei* Reade) native to river bottoms and swampy, acid soils of southern Georgia

and Alabama to northern Florida. Similar to Highbush in habit, but lower chilling requirement (earlier bloom) and longer period from flowering to maturity (45-90 days). Rabbiteye fruit has somewhat thicker skin and more (larger) seeds. And lowbush blueberry consist of *Vaccinium angustifolium*, *Vaccinium myrtilloides*, *Vaccinium brittonii*, *Vaccinium lamareckii* and *Vaccinium myrtilloides*. In this genus, *Vaccinium angustifolium* is the most abundant lowbush blueberry in older plantings, and is the lowbush blueberry of commerce. Blueberry breeding efforts begin in 1906 and have resulted in scores of newer cultivars with much improved fruit size, color and texture compared to native selections (Eck et al., 1990).

Blueberries are temperate fruits and they are in true berry fruit group as botanically. The cultivated types are highbush (*Vaccinium corymbosum*), rabbiteye (*Vaccinium ashei*) and lowbush blueberry (*Vaccinium angustifolium*) (Gough, 1994 and 1996; Lyrene, 2002). The highbush blueberry industry in

North America is concentrated in the six states. World blueberry production is about 270 Mt (Anonymous, 2007). United States of America is dominating world blueberry production and Canada, Poland and Holland are second importance. The success of blueberries has been phenomenal: the acreage planted to blueberries has increased faster than for any other temperate fruit crop. The blueberry is one of the most recently cultivated major fruit crops having been domesticated entirely within the 20th century (Prits and Hancock, 1992; Strik, 2005 and 2006).

The blueberry fruit has many desirable traits including small edible seeds, ease of preparation, and a fairly long shelf life. These traits together with the blueberry's unique flavor and its ability to be mechanically harvested, have led to rapid acceptance of the fruit among consumers. Blueberries can be eaten fresh or used for jelly, jam, syrup, pies, pastries or a juice. Blueberry fruits are also low in calories and sodium, contains no cholesterol, and is an excellent source of fiber. A major constituent of the fiber in blueberry is pectin, known for its ability to lower blood cholesterol levels (Prits and Hancock, 1992).

Black Sea Region of Turkey is one of the main origins of Caucasian whortleberry (*Vaccinium arctostaphylos*), bilberry (*Vaccinium myrtillus*), lingonberry (*Vaccinium vitis-idea*) and bog blueberry, bog whortleberry or bog bilberry (*Vaccinium uliginosum*) (Davis, 1978, Ağaoğlu, 1986; Trehane, 2004; Çelik, 2005). Native *Vaccinium* species and open pollinated types can grow natively over hundred years around the Black Sea Region of Turkey (Davis, 1978). These native blueberries consumes as jelly, dried or fresh fruits by local peoples in Turkey and especially by the settlers of Black Sea Region (Çelik, 2005; Çelik, 2006 and 2007).

Like the other ericaceous plants, blueberries thrive in acid soils with high organic materials and do best in soils with a pH between 4.5 and 5.2. Cultivars require from 120 to 160 growing degree days to ripen fruit. Blueberry cultivar adaptation and introduction studies began by sixtieths and still going on by now with new cultivars. Blueberries introduced to Australia in the beginning of 1950 but successful results have been obtained in 1970 with the selections (Clayton-Greene, 1989). On the other hand, Willis et al. (1994) determined the yield, berry weight, harvest time and survival of plants of 19 blueberry cultivars in West Louisiana. Makus et al. (1995) stated that rabbiteye blueberries are well adapted in southern part of America than other types. Yarborough (1997) stated that the native blueberry types can also be grown commercially besides cultivated ones and the berry gained from native blueberries could be mostly consumed as jelly or frozen but little part of them (<1%) has fresh usage. Blueberry culture is getting increase in both Australia and New-Zealand and the most performed commercial cultivars are Bluecrop, Berrygitte, Eliot, Nui and Reka (Patel, 1998). Wolfe and Brown (1998) found that the highest yielding

cultivars are Duke and Sierra for Kentucky. The adaptation and performance studies performed in Mississippi (Matta et al., 2002), Italy (Eynard et al., 1985), New-Zealand (Patel and Douglas, 1989), Canada (Bouchard, 1988), Finland (Hiirsalmi, 1989), Bulgaria (Stajanov, 1990), Holland (Wijsmuller, 1989), England (McAlister and Stewart, 1989), Russia (Paal, 1992), Norway (Haffner et al., 1998); Poland (Smolarz, 1998 a and b) and China (Yong et al., 1998) concentrated on growth, yield, quality and chemical properties of old or newly bred highbush or rabbiteye blueberries. Today, blueberry growing, industrializing enterprises and breeding studies are mostly do in America, Canada, Poland, Germany, England, Spain, Japan, China, Australia and Chile (Banados and Strik, 2006; Bell, 2006; Li et al., 2006; Tamada, 2006; Dressler, 2006, Smolarz and Pliszka, 2006; Dierking, 2006, Trehane, 2006; Strik, 2006). In Turkey, Erenoglu et al. (2001) tried to grow cultivated blueberry in Yalova but they failed due to improper soil and climatic conditions. Establishment of a blueberry planting is expensive; however the productive life has exceeded fifty or more years in some areas. It is inevitable that, blueberry performance is dependent upon the cultivars established and their relative positions in the planting, soils and climates. Great variations exist among cultivars in fruit quality, size and concentrated period of fruit ripening (Dozier et al., 1989; Eck et al., 1990; Gough, 1996). So, adaptation and performance study must be performed for both new areas and cultivars.

The aims of the present study were determining the performance of some northern highbush blueberry in İkizdere, Rize, northeastern part of Turkey and increase crop diversity for tea and hazelnut growers. This study is the first on blueberry cultivation of Turkey and includes some early data on northern highbush blueberries which adaptation studies are continuing in Black Sea Region on special and suitable areas with right soil and climatic conditions between 40-42 degree north latitudes.

2. MATERIALS AND METHODS

This study was conducted in 2002-2005 at the blueberry orchard with two years old potted plants of 'Berkeley', 'Ivanhoe', 'Jersey', 'Northland' and 'Rekord' northern highbush blueberry (*Vaccinium corymbosum* L.) cultivars. Plant materials introduced from Poland in the year of 2000 and two years old potted plants were planted in Ortaköy (Rize/ikizdere) district by 1.0 m in row and 2.0 m between row spacing at the same year. The soil of the experimental area was natural acidic silt-loam soil with 4.6 pH, 0.33% CaCO₃, 17.9 kg/da P₂O₅, 12.3 kg/da K₂O and 5.52% organic material. Two liters of moist peatmoss were placed under each plant at planting, and a surface mulch of aged-tea-waste with pine sawdust was applied 15 cm deep after planting and subsequently maintained at that depth. The design was randomized complete block with three replications and each

replication contained 10 plants. A year after planting, the fertilizing regimes consist of 33.0 kg 13N-13P-13K/da at budbreak followed by two applications of 11.2 kg/da ammonium sulfate at 6 weeks intervals. All plots received the same fertilizer and irrigation as needed during the experiment and plants pruned annually. Before harvest each year, the planting was enclosed in a polypropylene net to prevent bird depredation. Whole yields per plot and per harvest were recorded by the cultivars. Plant growth, bush, crown and berry characteristics and some phenological observations were also determined according to Ballington et al. (1984), Sapers et al. (1984), Siefker and Hancock (1986), Lyrene and Sharman (1988), Makus et al. (1995) and Kalt and McDonald (1996). The analyses of variance and Duncan's multiple range tests were used for statistical analyses and mean separations.

3. RESULTS AND DISCUSSION

The statistically differences on bush height, leaf size, internodium length, berry number, berry fresh weight, stem scar diameter and depth, yield, acidity, percentage TSS and pH were observed (Table 1, 2 and 3). Bush height was between 82.72 cm ('Berkeley') and 146.44 cm ('Ivanhoe'). According to Hancock et al. (1995), highbush blueberries have more than 75 cm bush length (Table 1). 'Berkeley' has the widest leaves (40.76 cm²) while 'Rekord' has smallest (18.62 cm²) ones. On the other hand, internodium length was greater at bush of Jersey (4.24 cm). And 'Northland'

gave the highest cluster number per bush (6.3) (Table 1). Berry number per cluster was about 55 in 'Jersey' and 11 in 'Berkeley'. 'Ivanhoe' (2.41 g), 'Berkeley' (2.19g) and 'Rekord' (1.98g) gave the largest berry as statistically (table 2). These findings are in parallel with the Siefker and Hancock's (1986) results. Hand harvested blueberries must have at least 2 grams berry weight (Ballington et al., 1984). So, all cultivars except for 'Jersey' and 'Northland' can harvest by hand. On the other hand, berry size is an important criteria for commercially acceptable (Ballington et al. 1984). Stem scar is an important penetration area for decay organisms after harvest. This scar must be small, shallow and dry (Strik et al., 1993, Gough, 1994; Gough 1996; Ballington et al., 1984). Stem scar diameter determined between 2.394 mm ('Berkeley') and 1.46 mm (Northland) (Table 2). Stem scar could be increase with the increment of berry largeness (Ballington et al. 1984; Hancock et al., 1995). However, stem scar depth has affection to dryness of stem scar area. Dry stem scar berries are suitable for storage, good for transportation and have longest shelf life (Gough, 1994; Gough, 1996). Yield per plant was between 455.2 g. ('Berkeley') and 2567.8 g. ('Ivanhoe'). Siefker and Hancock (1986), Gough (1994) and NeSmith (1999) proved that yield may increase five fold in older plants with the increasing of bushes per crown and cluster per bush. Blueberries are productive; however yield varies greatly with cultivars (Dozier et al., 1989).

Table 1. Bush, leaf and cluster characteristics of some northern highbush blueberry cultivars grown in northeastern part of Turkey*.

Cultivars	Bush height (cm)	Leaf size (cm ²)**	Internodium length (cm)	Cluster (numb./bush)
Berkeley	82.72 d	40.76 a	2.06 c	3.5 c
Ivanhoe	146.44 a	29.63 b	1.69 d	4.3 b
Jersey	107.00 c	21.55 c	4.24 a	4.6 b
Northland	104.82 c	19.11 c	1.70 b	6.3 a
Rekord	124.94 b	18.62 c	2.41 d	1.8 d

* Mean separation in columns by Duncan's multiple range test, 1% level

** The leaf size measured by PLACOM digital planimeter

Table 2. Berry number, weight, stem scar and stem depth of some northern highbush blueberries grown in northeastern part of Turkey*

Cultivars	Berry (numb./cluster)	Berry fresh wt. (g/berry)	Stem scar diameter (mm)	Stem scar depth (mm)	Yield (g/plant)
Berkeley	10.72 e	2.19 a	2.39 a	0.96 b	455.21 c
Ivanhoe	33.33 c	2.41 a	1.77 bc	1.11 b	2567.80 a
Jersey	54.74 a	1.32 b	1.69 bc	0.93 b	1447.40 b
Northland	46.92 b	0.94 b	1.46 c	1.37 a	1463.78 b
Rekord	25.64 d	1.98 a	2.16 ab	1.01 b	780.10 c

* Mean separation in columns by Duncan's multiple range test, 1% level

Table 3. Berry titratable acidity, soluble solids and pH of some northern highbush blueberries grown in northeastern part of Turkey*

Cultivars	Titratable acidity (%)	Total soluble solids (%)	pH
Berkeley	1.21 b	10.04 b	2.70 c
Ivanhoe	1.59 a	11.00 a	2.71 c
Jersey	1.14 c	11.00 a	2.93 a
Northland	1.03 d	10.04 b	2.92 ab
Rekord	0.96 b	10.17 b	2.91 b

* Mean separation in lines by Duncan's multiple range test, 1% level

Table 4. Bush and berry characteristics of some northern highbush blueberries grown in northeastern part of Turkey.

Traits	Northern Highbush Blueberry Cultivars				
	Berkeley	Ivanhoe	Jersey	Northland	Rekord
Growth habit	Semi erect	Erect	Semi erect	Broad and shallow	Broad and shallow
Plant vigor	Moderately vigorous	Extremely vigorous	Moderately vigorous	Moderately vigorous	Moderately vigorous
Crown volume (m ³)	0.25 ± 0.02	0.37 ± 0.03	0.35 ± 0.01	0.38 ± 0.02	0.56 ± 0.04
Internodium length (cm)	2.06 ± 0.09	1.67 ± 0.10	4.24 ± 0.13	1.63 ± 0.07	2.41 ± 0.24
Leaf width (mm)	4.97 ± 0.09	3.92 ± 0.44	3.41 ± 0.21	3.36 ± 0.28	2.57 ± 0.16
Leaf length (mm)	8.18 ± 0.06	7.70 ± 0.76	6.21 ± 0.28	5.62 ± 0.28	7.23 ± 0.31
Harvest date	20 July	10 July	25 July	25 July	20 July
Berry width (mm) (A)	16.95 ± 0.34	17.16 ± 0.40	13.56 ± 0.59	12.39 ± 0.82	16.49 ± 1.35
Berry length (mm) (B)	12.97 ± 0.53	13.05 ± 0.32	10.16 ± 0.36	9.69 ± 0.52	12.01 ± 0.86
Berry size (A*B)	219.56 ± 6.87	224.08 ± 9.32	138.13 ± 9.90	120.59 ± 13.04	200.43 ± 29.24
Berry size (1-10)**	7.90 ± 0.20	8.00 ± 0.21	6.30 ± 0.36	5.70 ± 0.42	7.75 ± 0.66
Berry color (1-10)**	9.10 ± 0.32	9.20 ± 0.47	4.00 ± 0.41	9.60 ± 0.32	7.65 ± 0.33
Big seeds (C)	44.00 ± 0.67	46.00 ± 1.68	44.00 ± 0.91	22.00 ± 1.07	25.00 ± 1.34
Small seeds (D)	6.00 ± 0.33	8.00 ± 1.19	5.00 ± 0.59	7.00 ± 0.70	3.00 ± 0.67
Total seeds (C+D)	50.00 ± 0.85	54.00 ± 1.76	49.00 ± 0.67	29.00 ± 1.56	28.00 ± 1.33
Berry weight (g/100 berry)	197.50	213.70	121.20	93.10	177.66
Maturity indices (TSS/acid)	8.32	6.93	9.66	9.77	10.59

*All values given after (±) represent Standard Deviation.

**Calculated by Ballington et al. (1984): Berry size as diameter: 1-10; Berry color as 1 dark-10 light.

Consumer prefers tasty, sweet and deep blue colored blueberry fruits (Sapers et al., 1984). For these reasons, titratable acidity, soluble solids and pH values determined for the cultivars in the experimental area. Titratable acidity was between 0.96% ('Rekord') and 1.59% ('Ivanhoe'). 'Ivanhoe' and 'Jersey' gave the highest total soluble solids (11.00%). pH responsible for color in berries. So 'Jersey' berry has the highest pH (2.93) and 'Berkeley' the lowest (2.70) ones (Table 3). On the other hand, maturity indices measured as TSS/acid is using for utilizing the berry usage and decay ratio. This ratio must be 6.5 or lower in unripe and purple berries for resistant against decay. Acidity must be high in processed blueberries (Sapers et al., 1984; Ballington et al., 1984). In the present study, maturity indices calculated between 6.93 ('Ivanhoe') and 10.59 ('Rekord') (Table 4). Growing habit and plant vigor differed to cultivars. 'Ivanhoe' plants had erect and very extremely vigorous bushes. This cultivar also had the highest bushes and larger berries (Table 4). However, 'Jersey' has the longest internodium at bushes and gave the most darkened blue berries. 'Ivanhoe' had more seeds than other cultivars and most of the seeds were big. It is true that, blueberry performance is dependent upon the cultivars, soils and climates (Dozier et al., 1989; Eck et al., 1990; Gough, 1996). So, adaptation and performance study must be performed for both new

areas and cultivars. The studied northern highbush blueberry cultivars ripened between 10 July and 25 July. As reported by Dozier et al. (1989), great variations exist among cultivars in fruit quality, size and ripening.

In conclusion, the early results proved that northern highbush blueberries adapted well in northeastern part of Turkey and gave good performance for both yield and growth. 'Ivanhoe' is the most yielding cultivar and good for fresh consumption with large berries like 'Berkeley' and 'Rekord' while 'Jersey' and 'Northland' are good for processing due to its small berries. The performance and adaptation studies in several areas through northern part of Turkey has natural acidic soils are continuing by adding the newest cultivars for both earliness and lateness. Commercial blueberry productions started via this study, presented and blueberry plantations are increasing. On the other hand, blueberry industry also established and popularity of blueberry getting increase in both Turkey and especially in Black Sea Region. Because blueberry is a miracle, healthy berry and it is the most profitable than tea and hazelnut. It is going to be a good alternative berry fruit for tea and hazelnut growers in Turkey due to its returns are higher than ever, its prices have hit all time records and demand is unprecedented.

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