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Full Length Research Paper

Estimation of fruit weight by cane traits for eight American blackberries (*Rubus fructicosus* L.) cultivars

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The present paper aimed to estimate fruit weight by their cane traits (the number of cane, cane height, cane diameter, and cane yield) for eight American blackberry cultivars (namely, Ness, Cherokee, Arapaho, Chester Thornless, Navaho, Black Satin, Dirksen Thornless and Cv. Jumbo) grown in Central Anatolia during 2002 - 2006. For this aim, average of fruit weight (dependent variable) for each cultivar was estimated by independent variables such as the number of cane, cane height, cane diameter, and cane yield in Multiple Regression Analysis (MRA). With respect to determination coefficients for each cultivar, it is clear that cultivars having the best fit (giving the best R^2 values) in MRA were found to be Black Satin (99.40%), Ness (99.16%), Navaho (96.46%), Dirksen Thornless (96.22%), Chester Thornless (91.92%), and Cv. Jumbo (91.26%), which meant that most (almost 100%) variation in fruit weight for these cultivars was explained by the number of cane, cane height, cane diameter, and cane yield. However, corresponding values for Arapaho and Cherokee cultivars was estimated as 2.88% and 33.2% of the total variation in fruit weight. It was concluded that number of canes had positive-significant effect on fruit weights of Dirksen Thornless ($P < 0.001$) and Cv. Jumbo ($P<0.01$), but negative-significant effect on that of Black Satin ($P < 0.001$). Cane height had positive-significant effect on fruit weights of Black Satin ($P < 0.001$) and Ness ($P<0.001$) cultivars, but negative-significant effect on cv. Chester Thornless ($P < 0.001$) and Dirksen Thornless ($P < 0.01$). Cane diameter had positive-significant effect on fruit weights of Black Satin ($P < 0.001$) and Chester Thornless ($P < 0.01$), Navaho ($P < 0.05$), Ness ($P < 0.01$) cultivars, whereas it had negative-significant effect on cv. Jumbo ($P < 0.05$). Cane yield had positive-significant effect on fruit weight of only Cv. Jumbo, but negative-significant effect on cv. Black Satin ($P < 0.001$), Chester Thornless ($P < 0.01$), Dirksen Thornless ($P < 0.001$), Navaho ($P < 0.001$) and Ness ($P < 0.001$). It was concluded that cane traits with the positive and negative effect on fruit weight provide useful clues for breeding proposes to improve fruit weight.

Key words: Blackberry, cane traits, fruit weight estimation, multiple regression analysis.

INTRODUCTION

Blackberries are widespread perennial shrubs native to the temperate Northern hemisphere. The blackberry is known to contain polyphenol antioxidants, which can regulate certain beneficial processes in mammals. Its root can be used in herbal medicine to treat diarrhea and dysentery diseases (Agaoglu and Eyduran, 2006). The blackberries are often classified according to their architectures, namely erect, semi-erect, and trailing (Strick et al., 2007). Erect-caned cultivars include the thorny ‘Brazos’, ‘Tupy’, and Cherokee, along with the thorn-less ‘Navaho’ and ‘Arapaho’. ‘Chester Thornless’, ‘Thornfree’ and ‘Loch Ness’ are cultivars with semi-erect architect-ture. Trailing cultivars include ‘Marion’ ‘Silvan’, ‘Thornless Ever-Green’ and the blackberry-raspberry hybrids ‘Boysen’ and ‘Logan’(Strick et al., 2007).

Numerous adaptation studies on blackberries have been carried out to determine the effects of yearly environ-

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Table 1. Monthly temperature and preciption in each year for Ankara ecology.

Year		Months												
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
2002	Precip. (mm)	39.6	9.3	23.8	102.7	29.6	41.9	42.9	12.2	31.7	25	41.3	29	429
	Temp. (°C)	-3.3	4.9	9.4	11.6	17.7	22.1	25.8	23.5	19.6	14.2	7.8	-0.2	12.8
2003	Precip. (mm)	51.6	43.7	6.9	61.7	27.3	17.7	7	39.1	1.1	65	0	0	321.1
	Temp. (°C)	5.6	0.6	4.2	10.7	20.6	24.1	24.9	25.8	19.3	14.9	8.1	2.5	13.4
2004	Precip. (mm)	77.9	20.1	39.5	37.3	18.6	25.8	4	22.3	9.3	44.2	22.9	0	321.9
	Temp. (°C)	1.2	2.3	7.8	12.7	17.1	21.4	25.7	24	20.9	15.5	7.8	2.7	13.3
2005	Precip. (mm)	29.7	48.2	68.4	62.7	27.5	47.6	18.7	1.8	4.8	15.9	43.9	17	386.2
	Temp. (°C)	3.6	3	6.8	12.5	17.6	20.9	26.3	26.6	20.3	12.2	7.1	3.6	13.4
2006	Precip. (mm)	60.9	84.7	43	14.1	13.3	9.2	39.1	0.3	82.8	19.9	17.5	1.8	386.6
	Temp. (°C)	-0.8	-0.4	8.1	14.3	18.1	23.1	24.7	28.7	19.5	14.9	6.3	1.3	13.2

State Meteorology Institute, Ankara 2006.

mental impacts and genotype (cultivar) on pomological traits like fruit weight, cane diameter, cane length, cane height, cane per plant, and others (Atila et al., 2006a; Atila et al., 2006b; Eyduran and Agaoglu, 2006; Eyduran et al., 2006; Eyduran et al., 2007). Chemical analysis of blackberries were conducted by Strik et al. (1996), Finn et al. (1998), Finn et al. (1999), Siriwoharn et al. (2005), Clark et al. (2005), Yorgey and Finn (2005), Connor et al. (2005a, b), Finn et al. (2005a, b) and Finn et al. (2005c, d, e). Berries having high weight are extremely important for blackberry breeders and economy of countries in world. However, there is no published information on estimation of fruit (berry) weight by cane traits in blackberry.

The present paper was conducted to estimate fruit weight by their cane traits (the number of cane, length of cane, diameter of cane, and productivity of cane) for eight American blackberry cultivars. The paper also aimed to determine the positive and negative effects of these cane traits on fruit weight of each blackberry cultivar for breeding propose.

MATERIALS AND METHODS

The field experiment was carried out on eight blackberry cultivars grown in farm of Horticulture Research and Application Farm, Faculty of Agriculture, University of Ankara during 2002 - 2006, (32°52´ North, 39°56´ East) and has a continental climate with wide, variations in temperature, both between seasons and different times of day. Its summers are hot and dry, but its winters are cold and wet. Meteorological data of experimental site are presented in Table 1.

Two rows for each plants was set at 2 x 2 meter spacing. Each year, blackberries were harvested during August-September period. The blackberry cultivars used in the present paper included cv. Ness, Cherokee, Arapaho, Chester Thornless, Navaho, Black Satin, Dirksen Thornless and Jumbo.

Fresh fruits of Berries were weighed and averages of fruit weight were estimated from each of 30-samples taken randomly from each of three plots for each blackberry cultivars. Cane weight, diameter, yield and height of shrub plants were found (Eyduran et al., 2007). Descriptive statistics of all traits are given in Table 2.

MRA was used to explain effects of independent variables on dependent variable.
Model of MRA can be written as follows:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \in_i \qquad (1)$$

i = 1, 2…n

Where, Y, is fruit weight and represent dependent variable; $X_1, X_2, ..., X_k$ are independent variables; namely, X_1: number of canes; X_2: cane height; X_3: cane diameter, and X_4: cane yield. $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ are regression coefficients (slopes); namely, β_0: intercept; β_1: the regression of fruit weight on number of canes; β_2: the regression of fruit weight on cane height; β_3: the regression of fruit weight on cane diameter, and β_4: the regression of fruit weight on cane yield and, $\in_i$ random error.

Equation 1 can be rewritten as $Y = X\beta + \varepsilon$ in matrix notation where X, design matrix; β, coefficients vector of regression coefficients, and $\in$, vector of random error. Regression coefficients can be estimated by Ordinary Least Square (OLS) Method. The method is based on minimizing $\sum_{i=1}^{n} e_i^2 = Y - \hat{Y}$, difference between observed Y values with predicted $\hat{Y_i}$ values. $\hat{\beta} = (X'X)^{-1}(X'Y)$ is solved by using OLS then $\beta_0, \beta_1, \beta_2 ... \beta_k$ are calculated (Duzgunes et al.,1983; Sokal and Rohlf, 1996; Eyduran et al., 2005). Statistical Analysis was performed using REG procedure of SAS program (SAS, 2006).

RESULTS AND DISCUSSION

General descriptive statistics of pomological traits such as fruit weight, number of canes, cane height, cane diameter, and cane yield are given in Table 2. As seen from Table 2, average fruit weight for eight American blackberry cultivars was found as 3.40 g and fruit weight ranged 1.00 to 5.50 g; average number of canes for eight American blackberry cultivars was calculated as 10.58 g

Table 2. Descriptive statistics of some pomological traits in blackberry.

Variable	N	Mean	Standard error	Minimum	Maximum
Fruit weight (g)	123	3.40	0.10	1.00	5.50
Number of canes	123	10.58	0.19	6.60	15.20
Cane height (cm)	123	225.92	3.49	100.00	300.00
Cane diameter (mm)	123	17.54	0.38	6.70	28.40
Cane yield	123	102.98	4.12	52.60	210.70

and number of canes ranged 6.60 to 15.20; average cane height for eight American blackberry cultivars was estimated as 225.92 cm and cane height ranged 100 to 300 cm; average cane diameter for eight American blackberry cultivars was estimated as 17.54 mm and cane diameter ranged 6.70 to 28.40 mm; and average cane yield for eight American blackberry cultivars was estimated as 102.98 and cane yield ranged 52.60 to 210.70.

Table 3 presents descriptive statistics of some pomological traits for each cultivar. Cultivar with the highest fruit weight was Chester Thornless (5.19 g), followed by Dirksen Thornless (4.90 g), Jumbo (4.14 g), Arapaho (3.09 g), Navaho (3.03 g), Ness (2.82 g), Cherokee (2.30 g), and Black Satin (2.01 g), with the lowest fruit weight. Fruit weight of cv. Arapaho (3.09 g) for this study was found less compared to that reported by Alleyne and Clark (1996) and Masabni and Wolfe (2002), who found average fruit weight of 3.22 and 3.50 g respectively. Our finding on fruit weight of Black cv. Satin (2.01 g) was less compared to the fruit weight (3.46 g) of this cultivar reported by Wu and Gu (1995). It was reported that cv. Choctaw and Shawne had fruit weight in range of 5.0 to 6.1 g (Perkins et al., 1997). In another investigation carried out in the Samsun (Turkey) Black sea region of Turkey the maximum fruit weight was recorded on the fruits of cv. Jumbo and the minimum fruit weight was recorded on cv. Navaho (Akbulut et al., 2003). In an investigation conducted in New Zealand and Oregon state regions, fruit weights for cv. Navaho was found as 6.58 and 5.87 (g/berry) (Connor et al., 2005a). These finding on fruit weight of Cv. Navaho were found higher compared to the results reported in this study. In another study carried out at Clarkswille and Hope locations of USA on the same cultivar, the cultivar's fruit weight was found to be 5.6 g (Clark et al., 2005). The finding was higher than our finding (3.03 g). Our finding on fruit weight of cv. Chester Thornless cultivar was in agreement with those of Strik et al. (1996) and Siriwoharn et al. (2005). Fruit weight results of numerous authors studying on different blackberry cultivars such as Obsidian (6.8 g), Waldo (4.8 to 6.4 g), Marion (5 to 5.2 g), Kotata (5 to 5.4 g), Siskiyou (6.9 to 7.8 g), Silvan (6.2 g), Black Butter (8.9 to 9.6 g); Nightfall (6.2 g), Black Diamond (5.8 g), Ranuni (7.6 g), ORUS830-4 (7.0 g), Shawnee (6 g) was generally higher compared to cultivars reported in the present paper (Strik et al., 1996; Finn et al., 1998; Finn et al., 1999; Siriwoharn et al., 2005; Finn et al., 2005a; Finn et al., 2005b; Finn et al., 2005c; Finn et al., 2005d; Finn et al., 2005e).

The highest number of canes determined in each of the cv. Jumbo (12.84), followed by Cherokee (11.76), Black satin (11.50), Navaho (11.14), Arapaho (10.96), Chester Thornless (9.96), Dirksen thornless (8.76), and Ness (8.30) in descending order, (Table 3).

It is clear (Table 3) that the blackberry cultivars with the highest cane height were Cherokee (266.82 cm), Chester Thornless (266.78 cm), and Arapaho (263.78 cm), followed by Navaho (229.80 cm), Jumbo (209.4 cm), Ness (208.64 cm), Dirksen Thornless (189.44 cm), and Black Satin (180.82 cm), with the lowest cane height.

The blackberry cultivar with the highest cane diameter was Chester Thornless (24.16 mm), but one the lowest cane diameter was Dirksen Thornless (15.35 mm).It was record 20.90 mm in cv Arapaho, 18.88 mm in cv. Navaho, 16.10 mm in cv. Ness, 15.98 mm in cv Jumbo, 15.64 mm in cv. Black Satin, and 15.48 mm in Cherokee (Table 3).

As shown in Table 3, the American blackberry cultivar with the highest cane yield and the lowest cane yield was found as Chester Thornless (206.60 g) and Jumbo (56.88 g). It was recorded 140.74 g in cv. Navaho, 93.16 g in cv. Ness, 87.96 g in cv. Arapaho, 87.04 g in cv. Dirksen Thornless, 85.32 g, in cv. Cherokee and (75.66 g) in cv. Black Satin. Cangi and Islam (2003), reported cane height of 67.3 to 253.2 cm, cane diameter of 3.49 - 7.99 mm and fruit weight of 1.88 - 4.0 g among different cultivars of blackberry with the lowest performance of cv. Jumbo in terms of yield (44.00 g) per plant. It was stated that Ness and Chester Thornless cultivars have highest and cv Cherokee and Boysenberry cultivars had lowest yield per plant (Akbulut et al., 2003).

It is well-known that ecology of an area affects performance of blackberry cultivars (Facteau et al., 1986). It is assumed that differences among pomological traits are due to the effects of genotype and environmental variations (Eyduran et al., 2006). Results of Multiple Regression Analyses for Eight American blackberry cultivars are presented in Table 4. As seen from Table 4, determination coefficient for Arapaho cultivar was found to be 2.88 (%), which meant that total variation of fruit weight explained by cane traits such as number of canes, cane height, cane diameter, and cane yield was too little. All the regression coefficients for cv. Arapaho were non-significant. That is, the effects of cane traits on fruit weight

Table 3. Descriptive statistics of some pomological traits for each American blackberry cultivar.

	N	Mean	Standard error	Minimum	Maximum
Arapaho					
Fruit weight (g)	15	3.09	0.07	2.26	3.34
Number of canes	15	10.96	0.32	9.40	12.70
Cane height (cm)	15	263.78	1.09	258.50	268.80
Cane diameter (mm)	15	20.90	0.55	17.20	23.40
Cane yield (g)	15	87.96	1.08	81.20	94.20
Black Satin					
Fruit weight (g)	15	2.01	0.07	1.54	2.36
Number of canes	15	11.50	0.56	7.00	13.90
Cane height (cm)	15	180.82	2.29	170.40	191.00
Cane diameter (mm)	15	15.64	0.93	9.00	19.50
Cane yield (g)	15	75.66	4.28	56.20	95.30
Cherokee					
Fruit weight (g)	15	2.30	0.13	1.00	3.00
Number of canes	15	11.76	0.47	9.60	14.50
Cane height (cm)	15	266.82	0.99	260.20	270.60
Cane diameter (mm)	15	15.48	0.62	12.00	19.40
Cane yield (g)	15	85.32	1.05	78.40	91.00
Chester Tornless					
Fruit weight (g)	15	5.19	0.06	4.82	5.50
Number of canes	15	9.96	0.19	9.00	11.00
Cane height (cm)	15	266.78	9.30	221.00	297.20
Cane diameter (mm)	15	24.16	1.03	18.00	28.40
Cane yield (g)	15	206.60	1.03	200.60	210.70
Dirksen Tornless					
Fruit weight (g)	15	4.90	0.11	4.35	5.36
Number of canes	15	8.76	0.30	6.60	10.00
Cane height (cm)	15	189.44	4.16	167.00	203.60
Cane diameter (mm)	15	15.35	0.54	11.00	18.00
Cane yield (g)	15	87.04	1.79	74.40	93.30
Jumbo					
Fruit weight (g)	15	4.14	0.05	3.84	4.38
Number of canes	15	12.84	0.71	7.00	15.20
Cane height (cm)	15	209.40	10.14	100.00	300.00
Cane diameter (mm)	15	15.98	0.36	13.50	17.70
Cane yield (g)	15	56.88	0.75	52.60	60.90
Navaho					
Fruit weight (g)	15	3.03	0.05	2.72	3.26
Number of canes	15	11.14	0.25	9.00	12.10
Cane height (cm)	15	229.80	0.46	227.40	232.80
Cane diameter (mm)	15	18.88	0.38	16.30	20.90
Cane yield (g)	15	140.74	3.76	120.60	158.80
Ness					
Fruit weight (g)	15	2.82	0.09	2.40	3.24
Number of canes	15	8.30	0.25	6.90	9.80
Cane height (cm)	15	208.64	2.77	198.30	222.40
Cane diameter (mm)	15	16.10	0.23	14.60	17.50
Cane yield (g)	15	93.16	1.96	83.50	102.90

of cv. Arapaho were non-significant. It could be said that Multiple Regression modeling for the cultivar may be insufficient.

Determination coefficient for cv. Black Satin was found to be 99.40 (%), which meant that total variation of fruit weight explained by traits such as number of canes, cane height, cane diameter, and cane yield were very high. All the regression coefficients were statistically significant (P < 0.001). The regression of fruit weight on number of canes for cv. Black Satin was estimated as – 2.171 (P < 0.001), which meant that we expect 2.171 g decrease in fruit weight with increasing 1 unit in number of canes, holding X2, X3, and X4 constants. The regression of fruit weight on cane height for Black Satin cultivar was found to be 0.02834 (P < 0.001), which meant that we expect 0.02834 g increase in fruit weight for each 1 cm increase in cane height, holding X1, X3, and X4 constants. The regression of fruit weight on cane diameter for Black Satin cultivar was found to be approximately 0.202 (P < 0.001), which meant that we expect 0.202 g increase in fruit weight for each 1 cm increase in cane diameter, holding X1, X2, and X4 constants. The regression of fruit weight on cane yield for cv.Black Satin cultivar was found to be – 0.01108 (P < 0.001), which meant that we expect 0.01108 g decrease in fruit weight for each 1 g increase in cane yield, holding X1, X2, and X3 constants. The cane height and cane diameter traits had positive effects on fruit weight, whereas number of canes and cane yield had negative effects on it.

Determination coefficient for Cherokee cultivar was found to be 33.20 (%), which meant that total variation of fruit weight explained by cane traits such as number of canes, cane height, cane diameter, and cane yield was found to be low. All the regression coefficients for Cherokee cultivar were non-significant. That is, the effects of cane traits on fruit weight of cv. Cherokee were non-significant. It could be said that Multiple Regression modeling for cv Cherokee was insufficient.

Determination coefficient for Chester Thornless cultivar was 91.92 (%), which meant that 91.92 (%) of total variation of fruit weight was explained by cane traits such as number of canes, cane height, cane diameter, and cane yield. The coefficient was found to be very high. Although the regression of fruit weight on number of canes was non-significant, the regressions of fruit weight on cane height (P < 0.001), cane diameter (P < 0.01), and cane yield (P < 0.01) were found to be significant. The regression of fruit weight on cane height for Chester Thornless cultivar was found to be – 0.01868 (P < 0.001), which meant that we expect 0.01868 g decrease in fruit weight for each 1 cm increase in cane height, holding X1, X3, and X4 constants. The regression of fruit weight on cane diameter for cv. Chester Thornless was approximately 0.11788 (P < 0.001), which meant that we expect 0.11788 g increase in fruit weight for each 1 cm increase in cane diameter, holding X1, X2, and X4 constants. The regression of fruit weight on cane yield for Chester Thornless cultivar was found to be – 0.02729 (P < 0.001), which meant that we expect 0.02729 g decrease in fruit weight for each 1 g increase in cane yield, holding X1, X2, and X3 constants. It could be said that Multiple Regression modeling for cv Chester Thorn-less gave sufficient explanation to total variations in fruit weight.

Determination coefficient for Dirksen Thornless cultivar was 96.22 (%), which meant that 96.22 (%) of total variation of fruit weight was explained by cane traits such as number of canes, cane height, cane diameter, and cane yield. The regressions of on fruit weight on number of canes (P < 0.001), cane height (P < 0.01), and cane yield (P < 0.001) was significant, whereas the regression of fruit weight on cane diameter was non-significant. The regression of fruit weight on number of canes for Dirksen Thornless cultivar was estimated as 0.69261 (P < 0.001), which meant that we expect 0.69261 g increase in fruit weight with increasing 1 unit in number of canes, holding X2, X3, and X4 constants. The regression of fruit weight on cane height for Dirksen Thornless cultivar was found to be – 0.01704 (P < 0.01), which meant that we expect 0.01704 g decrease in fruit weight for each 1 cm increase in cane height, holding X1, X3, and X4 constants. The regression of fruit weight on cane yield for Dirksen Thornless cultivar was found as –0.08942 (P<0.001), which meant that we expect 0.08942 g decrease in fruit weight for each 1 g increase in cane yield, holding X1, X2, and X3 constants. It is obvious in Table 4 that, for Dirksen Thornless cultivar, the number of canes had positive effects on fruit weight, whereas other traits had negative effects on it. It could be suggested that Multiple Regression modeling for Dirksen Thornless was very sufficient to explain total variations in fruit weight.

As shown in Table 4, determination coefficient for Cv. Jumbo was 91.26 (%), which meant that 91.26 (%) of total variation of fruit weight was explained by cane traits such as number of canes, cane height, cane diameter, and cane yield. The regressions fruit weight on number of canes (P < 0.01), cane diameter (P < 0.05), and cane yield (P < 0.001) were found to be significant, whereas the regression of fruit weight on cane height was non-significant. The regression of fruit weight on number of canes for Cv. Jumbo was estimated as 0.0433 (P < 0.01), which meant that we expect 0.0433 g increase in fruit weight with each increasing unit in number of canes, holding X2, X3, and X4 constants. The regression of fruit weight on cane diameter for Cv. Jumbo was found to be approximately –0.06 (P < 0.05), which meant that we expect 0.06 g decrease in fruit weight for each 1 mm increase in cane diameter, holding X1, X2, and X4 constants. The regression of fruit weight on cane yield for Cv. Jumbo was 0.04454 (P < 0.001), which meant that we expect 0.04454 g increase in fruit weight for each 1 g increase in cane yield, holding X1, X2, and X3 constants. As seen from Table 4, for the cultivar, the number of canes and can yield had positive effects on fruit weight, whereas other traits had negative effects on it. It could be suggested that Multiple Regression modeling for Cv. Jumbo was very sufficient to explain total variation of fruit

Table 4. Results of Multiple Regression Analyses for Eight American blackberry cultivars.

Variable	DF	Parameter estimate	Standard error	t value
Arapaho				
Intercept	1	3.97267	11.6234	0.34^{NS}
Number of canes (X1)	1	-0.00819	0.12817	-0.06^{NS}
Cane height (X2)	1	-0.01182	0.05880	-0.20^{NS}
Cane diameter (X3)	1	-0.10809	0.36881	-0.29^{NS}
Cane yield (X4)	1	0.05217	0.13907	0.38^{NS}
Model R^2 : 2.88 (%)				
Black Satin				
Intercept	1	-2.94093	0.37092	-7.93***
Number of canes (X1)	1	-0.21710	0.04225	-5.14***
Cane height (X2)	1	0.02834	0.00294	9.65***
Cane diameter (X3)	1	0.20200	0.02627	7.69***
Cane yield (X4)	1	-0.01108	0.00173	-6.41***
Model R^2 : 99.4 (%)				
Cherokee				
Intercept	1	13.40788	10.59466	1.27^{NS}
Number of canes (X1)	1	-0.24644	0.20303	-1.21^{NS}
Cane height (X2)	1	-0.08157	0.05306	-1.54^{NS}
Cane diameter (X3)	1	0.08279	0.05940	1.39^{NS}
Cane yield (X4)	1	0.14388	0.09334	1.54^{NS}
Model R^2 :33.2 (%)				
Chester Thornless				
Intercept	1	13.19909	1.70417	7.75***
Number of canes (X1)	1	-0.02405	0.03742	-0.64^{NS}
Cane height (X2)	1	-0.01868	0.00312	-5.99***
Cane diameter (X3)	1	0.11788	0.02715	4.34**
Cane yield (X4)	1	-0.02729	0.00727	-3.76**
Model R^2 :91.92 (%)				
Dirksen Thornless				
Intercept	1	11.61734	0.55554	20.91***
Number of canes (X1)	1	0.69261	0.13213	5.24***
Cane height (X2)	1	-0.01704	0.00434	-3.93**
Cane diameter (X3)	1	-0.11545	0.05562	-2.08^{NS}
Cane yield (X4)	1	-0.08942	0.01899	-4.71***
Model R^2 :96.22 (%)				
Jumbo				
Intercept	1	2.06350	0.45969	4.49**
Number of canes (X1)	1	0.04330	0.01349	3.21**
Cane height (X2)	1	-0.00025	0.00043	-0.58^{NS}
Cane diameter (X3)	1	-0.05999	0.02447	-2.45*
Cane yield (X4)	1	0.04454	0.00867	5.14***
Model R^2 :91.26 (%)				
Navaho				
Intercept	1	-3.47347	3.35562	-1.04^{NS}
Number of canes (X1)	1	-0.03035	0.01581	-1.92^{NS}
Cane height (X2)	1	0.03199	0.01515	2.11^{NS}
Cane diameter (X3)	1	0.08118	0.02838	2.86*
Cane yield (X4)	1	-0.01451	0.00279	-5.21***
Model R^2 :96.46 (%)				

Table 4. Contd.

Ness				
Intercept	1	0.09744	0.51918	0.19^{NS}
Number of canes (X1)	1	0.03260	0.01889	1.73^{NS}
Cane height (X2)	1	0.01793	0.00151	11.86***
Cane diameter (X3)	1	0.05194	0.01139	4.56**
Cane yield (X4)	1	-0.02286	0.00322	-7.11***
Model R^2 :99.16 (%)				

weight.

Determination coefficient for Cv. Navaho was 96.46 (%), which meant that 96.46 (%) of total variation in fruit weight was explained by cane traits such as number of canes, cane height, cane diameter, and cane yield (Table 4). The regressions of on fruit weight on number of canes and, cane height were found non-significant, but cane diameter (P < 0.05) and cane yield (P < 0.001) were significant. The regression of fruit weight on cane diameter for Cv. Navaho was approximately 0.0812 (P < 0.05), which meant that we expect 0.0812 g increase in fruit weight for each 1 mm increase in cane diameter, holding X1, X2, and X4 constants. The regression of fruit weight on cane yield for Cv. Navaho was – 0.01451 (P < 0.001), which meant that we expect 0.01451 g decrease in fruit weight for each 1 g increase in cane yield, holding X1, X2, and X3 constants. The number of canes and cane yield had negative effects on fruit weight, whereas other traits had positive effects on it. It could be suggested that Multiple Regression modeling for Cv. Navaho was determined as very sufficient to explain total variation in fruit weight.

Determination coefficient for Cv. Ness was 99.16 (%), which meant that 99.16 (%) of total variation in fruit weight was explained by cane traits such as number of canes, cane height, cane diameter, and cane yield (Table 4). The regression of fruit weight on cane height for Cv. Ness was found approximately 0.01793 (P < 0.001), which meant that we expect 0.01793 g increase in fruit weight for each 1 cm increase in cane height, holding X1, X3, and X4 constants. The regression of fruit weight on cane diameter for Cv. Ness was found to be approximately 0.052 (P < 0.05), which meant that we expect 0.052 g increase in fruit weight for each 1 mm increase in cane diameter, holding X1, X2, and X4 constants. The regression of fruit weight on cane yield for Cv. Ness was found as –0.023 (P < 0.001), which meant that we expect 0.023 g decrease in fruit weight for each 1 g increase in cane yield, holding X1, X2, and X3 constants. The cane yield had negative effects on fruit weight, whereas other traits had positive effects on it. It could be suggested that Multiple Regression modeling for Cv. Ness was very sufficient to explain total variation of fruit weight.

Conclusion

According to determination coefficients for each cultivar, it is clear that cultivars having the best fit (giving the best R^2 values) in MRA were determined as cv. Black Satin (99.40%), Ness (99.16 %), Navaho (96.46%), Dirksen Thornless (96.22%), Chester Thornless (91.92%), and Cv. Jumbos (91.26%). Multiple Regression Modeling gave good results for these cultivars. It was concluded that:

1. Number of canes had positive-significant effect on fruit weights of Dirksen Thornless (P < 0.001) and Cv. Jumbo (P <0 .01), but negative-significant effect on cv. Black Satin (P < 0.001).
2. Cane height had positive-significant effect on fruit weights of cv. Black Satin (P < 0.001) and Ness (P < 0.001), but negative-significant effect on cv Chester Thornless (P < 0.001) and Dirksen Thornless (P < 0.01).
3. Cane diameter had positive-significant effect on fruit weights of cv. Black Satin (P < 0.001) and Chester Thornless (P < 0.01), Navaho (P < 0.05), Ness (P < 0.01), whereas it had negative-significant effect on cv. Jumbo (P < 0.05).
4. Cane yield had positive-significant effect on fruit weight of only Cv. Jumbo, but negative-significant effect on cv. Black Satin (P < 0.001), Chester Thornless (P < 0.01), Dirksen Thornless (P < 0.001), Navaho (P < 0.001) and Ness (P < 0.001).

It could be suggested in the present paper that cane traits with the constructive effect on fruit weight for each cultivar might provide valuable clues for breeding proposes to improve fruit weight.

REFERENCES

Agaoglu YS, Eyduran SP (2006). Raspberry, Blackberry and Currant's Usefullness in Terms of Human Health, Res. J. Agric. Biol. Sci. 2(6): 314-315.

Akbulut M, Kaplan N, Macit I, Ozdemir C (2003). The determination of suitable Blackberry cultivars for Samsun- Carsama plain conditions of Turkey. I. National Kiwifruit and Small Fruits Symposium, Ordu. pp. 357-360.

Alleyne V, Clark JR (1996). Research Series. Arkansas Agricultural Experiment Station, No: 450(31-33): 3.

Atila SP, Agaoglu YS, Celik M (2006a). A Research on the Adaptation of Some Raspberry Cultivars in Ayaş (Ankara) Conditions. Pak. J. Biol Sci. 9(8): 1504-1508.
Atila SP, Agaolu YS, Celik M (2006b). A Research on the Adaptation of Some Blackberry Cultivars in Ayaş (Ankara) Conditions. Pak. J. Biol. Sci. 9(9): 1791-1794.
Cangi R, Islam A (2003). Adaptation of some blackberry cultivars in Ordu province (2000-2002 results). I. National Kiwifruit and Small Fruits Symposium, Ordu p, Ordu. pp. 348-352.
Clark JR, Moore JN, Lopez-Medina J, Finn CE, Perkins-Veazie P (2005). 'Prime-Jan' ('APF-8') and 'Prime-Jim' ('APF-12') primocane-fruiting blackberries. HortSci. 40: 852-855.
Connor AM, Finn CE, Alspach PA (2005a). Genotypic and environmental variation in antioxidant activity and total phenolic content among blackberry and hybrid berry cultivars. J. Am. Soc. Hort. Sci. 130: 527-533.
Connor AM, Finn CE, McGhie TK, Alspach PA (2005b). Genotypic and environmental variation in anthocyaninins and their relationship to antioxidant activity in blackberry and hybrid berry cultivars. J. Am. Soc. Hort. Sci. 130: 680-687.
Duzgunes O, Kesici T, Gürbüz F (1983). Statistics Methods I. University of Ankara, Publishings of Agriculture Faculty. Ankara.
Eyduran E, Ozdemir T, Alarslan E (2005). Importance of Diagnostics in Multiple Regression Analysis, J. Appl. Sci. 5(10): 1792-1796.
Eyduran SP, Agaoglu YS (2006). A Preliminary Examination Regarding Ten Raspberry Cultivars. Res. J. Agric. Biol. Sci. 2(6): 375-379.
Eyduran SP, Agaoglu YS, Eyduran E, Ozdemir T (2006). Examination of Pomological Features of Different Ten Raspberry Cultivars by the Methods of Various Statistics, Res. J. Agric. Bio. Sci., 2(6): 207-213.
Eyduran SP, Agaoglu YS, Eyduran E, Ozdemir T (2007). Comparison of Some Raspberry Cultivars'Herbal Features by Repeated Completed Design Statistic Technique, Pak. J. Biol. Sci. 10(8): 1270-1275.
Facteau TJ, Rowe KE, Chestnut NE (1986). Firmness of sweet cherry fruit following multiple applications of gibberellic acid, Horti. Sci. 56(5): 327.
Finn CE, Lawrence FJ, Strik BC (1998). Black Butte trailing blackberry. Hort. Sci. 32: 355-357.
Finn CE, Lawrence FJ, Strik BC, Yorgey BJ, DeFrancesco J (1999). 'Siskiyou' trailing blackberry. Hort. Sci. 34: 1288-1290.
Finn CE, Yorgey B, Strik BC, Hall HH, Martin RR, Qian MC (2005b). 'Black Diamond' trailing thornless blackberry. Hort. Sci. 40: 2175-2178.
Finn CE, Yorgey B, Strik BC, Martin RR (2005a). 'Metolius' trailing blackberry. Hort. Sci. 40: 2189-2191.
Finn CE, Yorgey B, Strik BC, Martin RR, Kempler C (2005e). 'Obsidian' trailing blackberry. Hort. Sci. 40: 2185-2188.
Finn CE, Yorgey B, Strik BC, Martin RR, Qian MC (2005c). 'Black Pearl' trailing thornless blackberry. Hort. Sci. 40: 2179-2181.
Finn CE, Yorgey B, Strik BC, Martin RR, Qian MC (2005d). 'Nightfall' trailing thornless blackberry. Hort. Sci. 40: 2182-2184.
Masabni J, Wolfe D (2002). Blackberry Cultivar Trial Results at UKREC. Princeton. http://www.uky.edu/Ag/NewCrops7current.htm
Perkins VP, Collins JK, Clark JR, Risse L (1997). Air shipment of "Navaho" blackberry fruit to Europe is feasible. Hort. iSscience., 32 (1): 132.
SAS (2006). SAS Institute,version 9.0. Inc. Cary, NC, USA.
Siriwoharn T, Wrolstad RE, Finn CE, Pereira CB (2005). Influence of cultivar, maturity and sampling on blackberry (*Rubus* L. hybrids) anthocyanins, polyphenolics, and antioxidant properties. J. Agric. Food Chem. (52): 8021-8030.
Sokal RR, Rohlf FJ (1996). Biometry. The Principles and Practice of Statistics in Biological Research. WH. Freeman and Company. New York.
Strick BC, Clark JR, Finn CE, Bañados MP (2007). Worldwide blackberry production. Hort.Technol. 17: 205-213.
Strik BC, Mann J, Finn C (1996). Percent drupelet set varies among blackberry genotypes. J. Am. Soc. Hort. Sci. (121): 371-373.
Wu WL, Gu Y (1995). Blackberry introduction and cultivation. Hort. Abs. 65: 5.
Yorgey B, Finn CE (2005). Comparison of 'Marion' to thornless blackberry genotypes as individually quick frozen and puree products. Hort. Sci. 40: 513-515.