

DETERMINATION OF THE YIELD AND QUALITY CHARACTERISTICS OF SOME STRAWBERRY VARIETIES GROWN IN THE OPEN FIELD OF YAHYALI (KAYSERI) ECOLOGICAL CONDITIONS

Mehmet Burak Ceran¹, Ercan Yildiz¹, Mehmet Yaman^{1*}

¹Erciyes University, Faculty of Agriculture, Department of Horticulture, Kayseri, Turkey



Abstract

This study was carried out to determine the performance of 6 different day-neutral varieties (Albion, Monterey, Portola, Sweet Ann, Kabarla and San Andreas) and 1 local genotype in open field in the ecological conditions of Yahyalı (Kayseri/Türkiye) in the 2021-2022 growing season. In the research, the first flowering date of the varieties was 19 March (local genotype) and 27 March (Portola), the harvest start date was 19 May (Kabarla) and 25 May (Albion), the end of harvest date was August 17 (local genotype) and 20 September (San Andreas). The harvest period was determined between 87 days (local genotype) and 122 days (Kabarla). In the experiment, the highest fruit weight and fruit firmness were determined in Sweet Ann variety with 11.74 g and 0.75 kg-force, respectively. It was determined that the total soluble solid (TSS) content amount in the cultivars varied between 6.16% (Sweet Ann) - 13.16 (local genotype), titratable acid content ranged between 0.48% (Sweet Ann) - 0.77 (San Andreas), pH value varied between 3.23 (San Andreas) - 4.03 (local genotype). While the highest lightness (L) fruits were obtained from Portola variety (31.09) in the experiment, the color intensity (chroma) varied between 31.22 (Albion) and 40.75 (Portola), the color angle value (h°) ranged between 38.61 (Albion) and 50.34 (Monterey and Portola). As a result, in Yahyalı (Kayseri) ecological conditions, in terms of yield and fruit quality characteristics such as fruit weight, color, firmness and TSS amount, Albion variety was found to be suitable, and then Sweet Ann and Kabarla varieties were important.

Keywords: quality, strawberry, Yahyalı, yield

1. INTRODUCTION

Strawberry plant could be grown in very different ecological conditions of the world. While strawberry cultivation is increasing day by day due to its high economic return, new high-yielding and high-quality varieties that can be grown in different climatic conditions are being developed in breeding studies (Yaman and Yılmaz, 2022). Strawberry cultivation in Turkey started in the 1970s (Paydaş and Kaşka, 1992), with rapid increases in recent years, the production has reached approximately 670 thousand tons today (TUIK, 2021). The fact that strawberry production can be done in almost every region in our country causes the fruit of the strawberry to be on the market for a very long time (Cengiz and Aslantaş, 2007).

The aim of this study is to determine the performance of different strawberry varieties and to determine the most suitable varieties in high altitude regions such as Yahyalı (Kayseri/Türkiye). In this way, it is planned to contribute to the expansion of strawberry cultivation in the region. In addition, it was aimed to compare the situation of being an alternative to apple, sugar beet,

sunflower seed cultivation, which is one of the plant activities that are already intensively cultivated in the region, and to increase the income level of the producer as a result.

2. MATERIALS AND METHODS

Materials

In the study, 6 different day neutral cultivars (Albion, Monterey, Portola, Sweet Ann, Kabarla and San Andreas) and 1 local genotype were used as plant material. Frigo seedlings of strawberry cultivars used in the research were obtained from “YALTIR AGRICULTURAL PRODUCTS INC.” was obtained from the company.

Methods

Cultivation was carried out in open field on the raised bed. Farm manure was applied at a rate of 2.5-3 tons/da, and then 3 raised beds were prepared with a distance of 60 cm. The raised beds are equipped with a top width of 65 cm and a height of 25 cm. A drip irrigation line was placed on the raised beds before planting and mulching was made with black plastic. The experiment was set up in a randomized block design with 20 plants in each plot, with 3 replications.

Frigo seedlings of the cultivars were first planted in viols at a ratio of 2:1:1 (peat:sand:perlite) on April 15, 2021, and then on May 10, 2021, they were staggered in two rows with 30x30 cm spacings on the raised beds as cross planting. Irrigation was done by sprinkling for one week after planting and then by drip irrigation method during the growing period. The fertilization program was started one month after planting and the program was planned through the plant nutrition consultant. Soil and foliar fertilizer applications were made throughout the season in 2022, when the trial data were obtained. For the plants to develop more vigorously, in 2021, which is the first planting year, all flowers and branches were cut off during the vegetation period (Ağaoğlu, 1986). In the study, phenological, morphological and pomological characteristics of cultivars in 2022 were evaluated. Accordingly, the features given below were examined by the methods followed by researchers (Bankaoğlu, 2017; Saraçoğlu, 2018; Oğuz, 2019) in strawberry adaptation studies.

Data Analysis

The study was carried out according to the randomized blocks experimental design with 3 replications and 20 plants in each replicate. The data obtained because of the experiment were subjected to analysis of variance according to the randomized blocks experimental design in the SAS package program and the averages were compared with the Tukey test.

3. RESULTS AND DISCUSSIONS

In this study, which was carried out by open cultivation on a land of 1110 m altitude in Yahyalı (Kayseri) district, 6 different day neutral varieties (Albion, Monterey, Portola, Sweet Ann, Kabarla and San Andreas) and 1 local genotype were used. The phenological characteristics of the strawberry cultivars used in the experiment are given in Table 1. In the research, the first flowering date of the cultivars was 19 March (local genotype) and 27 March (Portola), the full flowering date was 13 April (Monterey and San Andreas) and 23 April (Albion), and the fruit setting date was 27 April (Sweet Ann and San Andreas) and 5 May (Portola). Harvest start date among the varieties was determined with the earliest 19 May for Kabarla and the latest for Albion variety with 25 May. While the end of harvest date was between August 17 (local genotype) and September 20 (San

Andreas), the harvest period was determined between 87 days (local genotype) and 122 days (Kabarla).

Table 1. Some phenological characteristics of strawberry cultivars

Genotypes	FRFD*	FFD	FSD	RSD	HSD	EHD	HP
Albion	24 March	23 April	4 May	21 May	25 May	15 September	113
Monterey	24 March	13 April	2 May	19 May	23 May	15 September	115
Portola	27 March	20 April	5 May	16 May	20 May	10 September	113
Local	19 March	18 April	2 May	19 May	22 May	17 August	87
Sweet Ann	23 March	15 April	27 April	16 May	21 May	6 September	108
Kabarla	23 March	21 April	2 May	15 May	19 May	18 September	122
San Andreas	21 March	13 April	27 April	19 May	23 May	20 September	120

*: FRFD-First Flowering Date; FFD-Fuly Flowering Date; FSD-Fruit Setting Date; RSD-Ripening Start Date; HSD-Harvest Start Date; HLD-End of Harvest Date; HP-Harvest Period

In the studies carried out in different ecologies of Türkiye, the cultivars showed obvious differences in terms of their phenological characteristics. Kaleci and Günay (2006) determined that the first flowering in 7 different strawberry cultivars was on March 19 in the first year of the experiment and on March 28 in the second year, the harvest started from mid-May in the first year of the experiment, and there was a one-week delay in the second trial year. Gündüz and Özdemir (2010) determined that the harvest time in open culture varies between 103.3 and 152.0 days according to the varieties. Saraçoğlu (2013) reported that the first flowering in 6 different strawberry cultivars was between April 4 and April 13, and the first harvest was between May 24 and June 3. Özok (2021) determined that the first flowering changed between 8 March and 16 April, and the first harvest was carried out between 11 and 20 May. As can be understood from the studies, many factors such as the genetic structure of the varieties, planting time, ecological conditions, growing systems, seedling type (fresh, frigo, tube) affect the phenological characteristics. While one of the goals in strawberry cultivation in recent years has been to provide a long harvest season, researchers recommend day-neutral varieties for this (Medina et al., 2011; Ruan et al., 2013).

The findings regarding the fruit sizes and color features of the strawberry cultivars included in the experiment are shown in Table 2. The lowest fruit weight was obtained from the local genotype (3.57 g), and the highest was obtained from the Sweet Ann (11.74 g) variety. While the highest fruit width value was obtained from Sweet Ann variety with 27.90 mm, the highest fruit length value was obtained from Kabarla variety with 31.06 mm, the lowest fruit width and length values were obtained from local genotype with 15.33 mm and 15.22 mm, respectively. It was determined that the fruit shape was oval in Portola cultivar and local genotype, and conical in the others. Among the varieties, the brightest fruits were obtained from Portola variety ($L^*=31.09$), while the lowest fruit brightness value was obtained from Kabarla with 28.93 and Monterey with 29.11. The highest value in terms of chroma value, which expresses the color intensity, was obtained from Portola variety

(C=40.75). The lowest color intensity was obtained from Albion with 31.22 and Kabarla with 31.35. Monterey and Portola cultivars had the highest fruit color angle value (h°) with 50.34, and the lowest value was obtained from Albion cultivar ($h^\circ=38.61$).

Table 2. The fruit sizes and color features of the strawberry cultivars

Varieties	F. Weight (g)	F. Width (mm)	F. Length (mm)	Fruit Shape	L	Chroma	Hue
Albion	7.73 bc ⁽¹⁾	21.23 c	25.74 b	Conical	30.64 ab	31.22 d	38.61 d
Monterey	7.90 bc	25.42 ab	28.44 ab	Conical	29.11 b	37.80 ab	50.34 a
Portola	7.99 bc	25.06 ab	25.98 b	Oval	31.09 a	40.75 a	50.34 a
Local	3.57 d	15.33 d	15.22 c	Oval	29.85 ab	35.35 b	42.33 c
Sweet Ann	11.74 a	27.90 a	27.74 b	Conical	30.21 ab	35.04 c	46.22 b
Kabarla	8.87 b	26.57 ab	31.06 a	Conical	28.93 b	31.35 d	42.03 cd
S.Andreas	7.29 c	23.99 bc	25.71 b	Conical	29.96 ab	34.50 c	42.21 c
HSD (%5)	1.28	3.63	2.76	---	1.79	2.55	3.48

(1): Differences within each treatment (control, bacteria effect) are shown with different letters. HSD: Honestly Significant Difference.

As in many fruit species, fruit size is one of the important criteria in terms of attractiveness and fruit quality in strawberry. Genetic structure of the plant, environmental factors, growing environments, and cultural processes (irrigation, fertilization, mulching, etc.) has a significant effect on fruit size in strawberry. Özbahçali (2014) in his study conducted with 6 different strawberry varieties in Erzurum ecology, determined that fruit weight varies between 6.2 g and 9.0 g. Sonmez et al. (2016) determined the highest fruit weight with 17.6 g (Sabrina) in their study conducted with 4 different strawberry cultivars, while the fruit weight values in other cultivars varied between 12.8-14.8 g. Özok (2021), in his study with 16 different cultivars, determined that fruit weights varied between 4.80 g and 17.81 g on the basis of cultivars, while Monterey, and Portola cultivars had the largest fruits. When the results obtained and the results of the literature studies are compared, it is seen that the fruit size of strawberry varieties grown in Yahyalı (Kayseri/Türkiye) ecological conditions is at an average level. Color is an important quality factor in strawberry production, and bright red color is accepted instead of very dark and very light colored fruits in table strawberry cultivation (Yılmaz, 2009). Oguz et al. (2017) reported that L* values varied between 37.42 (Portola) - 41.37 (Kabarla), C values between 45.48 (Monterey) - 50.21 (San Andreas) and hue values between 30.61 (Monterey) - 34.66 (Portola) in different strawberry cultivars. Saraçoğlu (2018) determined that the L* value varied between 33.0-39.4, the C value between 45.3-50.6 and the h° value between 25.5-36.9 in terms of fruit color in 8 strawberry cultivars. Ecological factors such as temperature and lighting, especially genotype, and maintenance conditions influence the external color formation of the fruit. It is reported that there is a direct proportional relationship between red color synthesis in fruit and light intensity (Karaçalı, 2002).

Strawberry cultivars differed statistically in terms of some pomological characteristics (Table 3). According to this, Sweet Ann (0.75 kg-force) had the highest fruit firmness value among the

cultivars, while the lowest value was obtained from the local genotype with 0.45 kg-force. It was determined that the total soluble solid (TSS) content in the cultivars varied between 6.16 (Sweet Ann) - 13.16% (local genotype), the titratable acid (TA) content between 0.48 (Sweet Ann) - 0.77% (San Andreas) and the pH value between 3.23 (San Andreas) - 4.03 (Sweet Ann and local genotype). The highest taste scores of the cultivars were found in Monterey (4.6), while the lowest score was obtained from Kabarla (3.0). The highest smell scores were found in Portola (4.0) and Sweet Ann (3.5) cultivars, while the smell score of Kabarla (2.5), Albion and Monterey (2.8) cultivars were found to be lower.

Table 3. Some pomological characteristics of strawberry cultivars

Varieties	Fruit Firmness	SSC (%)	Acidity (%)	pH	SSC/Acidity	Taste	Smell
Albion	0.69 b ⁽¹⁾	9.73 b ⁽¹⁾	0.72 a	3.89 ab	13.51 bc	4.0 bc	2.8 de
Monterey	0.51 d	8.93 b	0.54 b	3.88 ab	16.54 b	4.6 a	2.8 de
Portola	0.59 c	7.00 cd	0.51 bc	3.84 ab	13.73 bc	3.6 c	4.0 a
Local	0.45 e	13.16 a	0.49 c	4.03 a	26.86 a	4.2 ab	3.0 cd
Sweet Ann	0.75 a	6.16 d	0.48 c	4.03 a	12.83 bc	4.0 bc	3.5 b
Kabarla	0.57 c	7.66 c	0.55 b	3.71 b	13.93 bc	3.0 d	2.5 e
S.Andreas	0.67 b	8.90 b	0.77 a	3.23 c	11.56 c	3.8 bc	3.2 bc
HSD (%5)	0.05	1.01	0.04	0.25	3.91	0.50	0.30

(1): Differences within each treatment (control, bacteria effect) are shown with different letters. HSD: Honestly Significant Difference.

Fruit firmness is one of the most important quality parameters in terms of post-harvest shelf life and the consumer's preference. Özok (2021), in his study with 16 different cultivars in Bursa conditions, determined that the fruit firmness value in cultivars varied between 0.18 and 0.69 kg-force. Fruit firmness can be affected by many factors such as genotype, fruit size, ecological factors, and growing conditions. In a study conducted by Bankaoğlu (2017) with Camarosa, Fortuna, Mojave and San Andreas strawberry varieties grown in high tunnels in Çamoluk (Giresun) conditions, it was reported that the highest amount of TSS was obtained from San Andreas (7.21%) and the lowest from Camarosa (5.95%). Oguz et al. (2017) determined that in 5 different strawberry cultivars grown in Nevşehir ecological conditions, the content of TSS varied between 9.45% (Portola) and 14.56% (Monterey), and TA content between 0.81% (Portola) and 0.99% (Albion). Özok (2021) determined that the amount of TSS in strawberry cultivars varied between 6.4% and 9.9%, and TA content varied between 0.53% and 0.91%. The amount of TSS in strawberry fruits is among the properties that affect fruit quality, but it is directly related to the formation of taste. It has been stated that the TSS and TA contents in fruits are affected by the genotype, the maturity of the fruit, the climate (temperature, precipitation, light, etc.), soil characteristics and growing conditions (Karaçalı, 2002).

In conclusion, as in many fruit species, absolute adaptation studies should be carried out to recommend any variety to different regions in strawberry cultivation. Because environment x genotype interaction is very important in strawberry. In the research, Albion cultivar was superior in fruit color, Sweet Ann cultivar in fruit weight and fruit firmness, and local genotype in TSS content. On the other hand, Kabarla cultivar took the second place among the cultivars in terms of fruit

weight and fruit color, and Albion cultivar in terms of flesh firmness and TSS content. When all the data are evaluated together, it is thought that the Albion cultivar should be preferred in the first place in terms of commercially intensive cultivation for this region, high adaptability, not having problems in seedling supply, and providing the same quality and productivity throughout the season. As an alternative to this cultivar, Sweet Ann and Kabarla cultivars can be shown as varieties with high performance, respectively.

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