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Araştırma Makalesi/*Research Article (Original Paper)*

Agro morphological Properties of Plums (*Prunus domestica* L.) Genotypes Grown in Van-Region

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Abstract: This study was conducted in the years 2010 and 2011 to determine plum genotypes naturally grown in Van region and to identify biological diversity in the region. Phenological, pomological and morphological properties of available plum genotypes were assessed and a total of 45 genotypes were monitored for two years. Among the investigated genotypes, 10 were selected as promising plum genotypes. Budburst dates of promising genotypes varied between 5-26 April, initiation of flowering dates varied between 30 April - 14 May; full-bloom dates varied between 03-17 May; end of flowering dates varied between 11-24 May; and harvest dates varied between 01 August-10 September. Fruit weights of promising genotypes varied between 8.66-25.59 g; fruit widths between 22.29-31.22 mm; fruit lengths between 22.98-35.86 mm; fruit heights between 23.16-33.32 mm; seed weights between 0.59-1.45 g; seed widths between 9.56-19.23 mm; seed lengths between 11.91-20.97 mm; fruit volumes between 12.00-32.00 cm³; fruit densities between 0.80-1.53 g cm^{-3} fruit flesh/seed ratios between 11.50-23.09%; fruit juice titratable acidity values between 0.89-2.62%; pH values between 3.75-4.08; total soluble solids contents (TSSC) between Brix° 10.5-15.5; vitamin C contents between 9.84-29.80 mg $100g^{-1}$, tree canopy heights between 2.30-6.00 m; and canopy widths between 2.30-7.40 m.

Keywords: Biological diversity, Plum, Van

Van Bölgesi'nde Yetiştirilen Erik (*Prunus domestica* L.) Genotiplerinin Agro Morfolojik Özellikleri

Öz: Bu çalışma, Van bölgesinde doğal olarak yetişen erik genotiplerinin ve bölgedeki biyolojik çeşitliliğinin belirlenmesi amacıyla 2010 ve 2011 yıllarında gerçekleştirilmiştir. Mevcut erik genotiplerinin fenolojik, pomolojik ve morfolojik özellikleri değerlendirilmiş ve iki yıl boyunca toplam 45 genotip gözlemlenmiştir. İncelenen genotipler arasında, 10 ümitvar erik genotipi seçilmiştir. Ümitvar genotiplerin tomurcuk patlamasının 5-26 Nisan tarihleri arasında tarihinin değiştiği, çiçeklenme tarihlerinin 30 Nisan - 14 Mayıs tarihleri arasında değiştiği; tam çiçeklenme tarihlerinin 03-17 Mayıs tarihleri arasında değiştiği; çiçeklenme sonunun 11-24 Mayıs tarihleri arasında değiştiği; ve hasadın 01 Ağustos-10 Eylül tarihleri arasında değiştiği belirlenmiştir. Ümitvar genotiplerin meyve ağırlıkları 8.66-25.59 g; meyve çapının 22.29-31.22 mm; meyve uzunluğu 22.98-35.86 mm, meyve yüksekliği 23.16-33.32 mm; tohum ağırlığı 0.59-1.45 g arasında; tohum genişlikleri mm 9.56-19.23 mm; ve tohum uzunlukları 11.91-20.97 mm arasında değişmiştir. Meyve hacimleri 12.00-32.00 cm³ arasında; meyve yoğunluğu ise 0.80-1.53 g / cm³; meyve eti / tohum oranı% 11.50-23.09; meyve suyu titre edilebilir asitlik değerleri% 0.89-2.62 arasında; pH değeri 3.75-4.08 arasında; toplam suda çözünebilir kuru madde içeriği (SÇKM) 10.5-15.5 Briks°; C vitamini içeriği 9.84-29.80 mg / 100g arasında; ağaç taç yüksekliği 2.30-6.00 m arasında; ve ağaç taç genişliği 2.30-7.40 m arasında bulunmuştur.

Anahtar kelimeler: Biyolojik çeşitlilik, Erik, Van

Introduction

Plant genetic resources are significant natural resources to meet various basic needs of humans, especially food demands. Today, these valuable resources are continuously depleting or disappearing because of various reasons (Anonymous 2010). Breeding studies can reach to desired outcomes only with the use of available genetic diversity. Turkey is located at intersection of gen centers of the world, has various ecological conditions, has hosted several civilizations, and thus is quite rich in plant species and cultivars (Ağaoğlu et al. 1995). Potential use of this genetic richness will only be possible through selection of proper genotypes with the breeding studies on available populations. Selection is the first step of breeding studies and play a significant role in identification of several fruit species and cultivars cultured today (Özbek 1978; Güleryüz 1988; Şeniz 1990).

Plums (*Prunus domestica*) have several varieties worldwide and can be grown in quite different ecologies. Therefore, they have quite widespread worldwide (Özakman et al. 1994). The common plum varieties of Turkey include *Prunus*

domestica (European plums), *Prunus ceresifera* (green plums); *Prunus institia, Prunus spinosa*; *Prunus divericata* and *Prunus salicana* (Japonese plums). Green plums are all domestic, some of European plums are domestic and some are foreign and all of the Japanese plums are foreign species (Koyuncu and Aşkın 1993; Özçağıran et al. 2004). Several studies carried out worldwide to elucidate rich plum genetic resources (Nictaro 1983; Önal et al. 1988; Ayanoğlu et al. 1992; Ayanoğlu and Yılmaz 1995; Özkarakaş and Ercan 2000; Arvas 2005).

As it was in other fruit species, Turkey has a rich genetic diversity in plums. Such a rich diversity also exists in Van Lake basin with a micro climate located in Eastern Anatolia Region Van central town, Erciş, Gevaş and Edremit districts are important fruit culture sites of Van Lake basin. Several domestic and foreign plum species are grown in the region. However, majority of available plum population was obtained from the seeds. Therefore, there is a rich genetic diversity within the available population. Identification of such rich genetic diversity will have significant contributions to both fruit culture of the region and further breeding researches to be carried out on plum species of the region. This study was conducted to put forth phenological, pomological and morphological characteristics of plum genotypes naturally grown in Erciş town center and villages. The plum genotypes with superior characteristics will be identified in detail and potential of the region for fruit genetic resources will be determined.

Material and Method

This study was carried out with local plum (*Prunus domestica* L.) genotypes naturally grown in Erciş town center, Alkanat, Gölağzı and Kışla locations and Kadirasker, Bayramlı and Işıklı villages of central town between the years 2010-2011. In the first year, the plum trees with large fruits with high flesh ratios and free of disease and pests were screened and 45 genotypes were observed. Then, phenological, pomological and morphological characteristics of these genotypes were investigated for two years. At the end of second year, promising genotypes were selected by using the weighted rating method as specified by Yazgan (1989) and Özkarakaş et al. (2006) and 10 promising genotypes were selected. Selected promising genotypes were monitored through measurements in 15-day intervals on 20 fruits. Results were presented in graphs. Since the measurement-based attributes are quite variable, mean values of these parameters are presented with standard deviations.

Fruit flesh ratio, fruit volume, fruit density and flesh firmness were determined in accordance with Yamankaradeniz (1982), Karaçalı (1990) and Ercişli (1996). Fruit base color and flesh color of the selected genotypes were determined with a colorimeter. Fruit aroma, juiciness and taste were scored by a panelist group composed of 5 people (Ercişli, 1996). Group scores were added and averaged. Fertility values were determined through comparisons of the genotypes with each other (Kara and Gerçekçioğlu 1992; Ercişli 1996). UPOV "Guidelines for the conduct of tests for distinctness, uniformity and stability in European Plum" was used to determine shape index of the fruits (Anonymous, 2002). For vitamin C contents, the method specified by Cemeroğlu (2007) was used with slight modifications and HPLC device was used for analyses. All the analysis was repeated 20 times to achieve accuracy. Average data were calculated by computer office programs and given with standard deviations.

Results and Discussion

Phenological, pomological, morphological and chemical characteristics of promising plum genotypes are provided in Table 1 and fruit development curves are presented in Figure 1.

Bud burst dates of promising plum genotypes varied between 5 April (EES2) – 26 April (EES11-40), initiation of lowering between 29 April (EES30)- 14 May (EES11), full bloom between 03 May (EES36) -17 May (EES11-20), end of flowering between 11 May (EES30-36) -24 May (EES11). The earliest harvest was made on 01 August (EES2-36) and the latest harvest was made on 10 September (EES40-11). Number of days from full bloom to harvest varied between 81 days (EES2) – 122 days (EES40), number of days from the beginning and end of flowering varied between 10 days (EES11-31) - 22 days (EES45) (Table 1). The number of days from full bloom to harvest was reported as between 99-119 days by Köksal and Geçekçioğlu (1992), as between 98-103 days by Güleryüz and Ercişli (1995). In other studies carried out on plums of Turkey, flowering durations were reported as between 8-20 days (Özçağıran 1978; Aşkın and Koyuncu 1992; Güleryüz and Ercişli 1995; Özakman et al. 1995). Hınıslıoğlu (1997) reported the flowering durations as between 9-15 days in the first year and as between 8-13 days in the second year. Previous researchers carried out studies with different plum cultivars at different ecologies and fruit ripening periods were reported as between 4 July-14 August in Tokat province by Köksal and Gerçekçioğlu (1992), as between 18 May-3August in Yalova region by Onur (1997), as between 7 June-13 September in Menemen district by Özakman et al., (1995); as between 18 July – 6 September in Van region by Aşkın and Koyuncu (1992).

Present number of days from the full-bloom to harvest and flowering durations well comply with the findings of the other researchers. Phenological observations may vary with the ecological conditions and genotypes.

Canopy width of promising genotypes varied between 2.3 m (EES20)-7.4 m (EES45), canopy heights varied between 2.30 m (EES17)-6 m (EES45), canopy shape was “prolate” in seven genotypes, “semi-vertical” in two genotypes (EES11-20) and “vertical” in one genotype (EES40) (Table 1). Kuleyn (1995) reported canopy heights of 4-year old plum trees as between 1.60 -2.50 m, canopy widths as between 1.20 -2.00 m; Beyhan (2005) reported canopy heights as between 1.50-5.00 m, canopy widths as between 1.00-4.00 m, canopy shapes as “semi-vertical” and “vertical”. Plant morphological characteristics usually vary with the age and ecological conditions.

Fruit stone attachment to the fruit flesh was “free” in two genotypes (EES2-40), “attached” in the other genotypes; stone weights varied between 0.59 g (EES36)-1.45 g (EES45), stone lengths varied between 11.91 mm (EES48)-20.97 (EES20) and stone widths varied between 9.56 g (EES36)-19.23 g (EES48) (Table 1). Stone weights were reported as between 0.64-2.96 g by Önal et al. (1994), as between 0.70-2.20 g by Beyhan (2005) and as between 1.39-2.56 g by Balık (2005). Present stone weights were close the values reported for local plum cultivars in previous studies, but smaller than the values reported for standard plum cultivars.

Fruit weights of promising genotypes varied between 8.66 g (EES36)-25.59 g (EES45), fruit lengths between 22.98 mm (EES36)- 35.86 mm (EES11), fruit widths between 22.29 mm (EES36)-31.22 mm (EES45), fruit heights between 23.16 mm (EES36)-33.42 mm (EES45), fruit volumes between 12 ml (EES2)-32 ml (EES45), fruit densities between 0.80 kg m^{-3} (EES45)-1.53 kg m^{-3} (EES2), fruit flesh/stone ratios between 11.50 (EES31)-23.09% (EES11), fruit flesh firmness between 1.20 kg cm^{-2} (EES31)-3.3 kg cm^{-2} (EES17) (Table 1).

Beyhan (2005) reported fruit weights as between 12.63-29.17 g, fruit diameters as between 25.50-34.70 mm, fruit lengths as between 28.60-43.70 mm, fruit heights as between 25.30-37.20 mm; Özçağıran (1976) reported fruit weights as between 19.0-58.0 g; Arvas (2005) reported fruit weights as between 7.58-52.22 g, flesh firmness as between 1.60-0.90 kg cm^{-2}, flesh/stone ratios as between 10.80-24.35%; Önal et al. (1994) reported fruit weights as between 9.81-69.95 g;Hınıslıoğlu (1997) reported fruit lengths as between 23.90-43.70 mm, fruit heights as between 25.4-45.8 mm, fruit flesh firmness as between 1.80-3.80 kg cm^{-2}; Balık (2005) reported fruit diameters as between 47.41-32.82 mm, fruit heights as between 45.07-33.70 mm, fruit lengths as between 47.55-32.47 mm; Kuleyn (1995) reported fruit diameters as between 31.00-45.68 mm, fruit lengths as between 28.48-49.40 mm; Güleryüz and Ercişli (1995) reported flesh firmness values as between 1.70-1.75 kg cm^{-2}; Onur (1997) reported flesh firmness as between 5.90-8.00 kg cm^{-2}.

Present findings were close the values reported for local plum cultivars in previous studies, but smaller than the values reported for standard plum cultivars. Fruit physical attributes are controlled by several genes and usually vary with the cultivars, ecological factors and cultural practices, thus such comparisons should be made under more controlled conditions. Care practices were not implemented in promising genotypes, thus the values were smaller than the values of standard cultivars. Fruit size demands should be considered along with the yield and consumer demands and industry requirements, therefore, researches should go on present plum genotypes.

Fruit shape of promising genotypes was “elliptical” in five genotypes and “oval” in five genotypes (Table 1). Beyhan (2005) indicated fruit shape of standard and local plum cultivars as “circular” and “oval”.

Fruit skin color of promising genotypes was “yellow” in two genotypes (EES2-45), “light red” in two genotypes (EES11-20), “red” in four genotypes (EES17-30-31-36) and “purple” in two genotypes (EES40-48). Fruit flesh color was “red” in EES36, “green” in EES40 and “yellow” in the other genotypes (Table 1). Fruit skin color of wild plums (*Prunus spinosa* L.) were reported as “yellow, dark purple, dark red, purple” by Ertürk et al. (2009); Beyhan (2005) reported skin color of some standard and local cultivars as “purple, yellow, green and red”; Polunin (1991) reported skin color of *Prunus domestica* cultivars as “purple, red and black”. While skin color of promising genotypes had a greater range of color, flesh color was mostly “yellow”. Such a tendency might be related to plants genetics and also related to changes in solar radiation and temperatures.

Fruit aroma of the promising genotypes was “rich” in five genotypes (EES2-36-45-48), “moderate” in five genotypes (EES11-17-20-31-40) and “poor” in one genotype (EES30). Fruit juiciness was “moderate juicy” in EES20 and “juicy” in the other genotypes. Fruit taste was “well” in four genotypes (EES11-17-20-31) and “very well” in the other genotypes. Fruitfulness was “high” in two genotypes (EES36-40), “low” in EES2 and “moderate” in the other genotypes (Table 1).

Titratable acidity values of the promising genotypes varied between 0.896 (EES2)-2.62% (EES30), total soluble solids contents varied between 10.5 (EES17)-15.5% (EES2), fruit juice pH values varied between 3.75 (EES30)-4.08 (EES40), fruit juice vitamin C contents varied between 9.84 mg 100 g^{-1} (EES40)-29.80 mg 100 g^{-1} (EES2) (Table 1). Total soluble solids contents were reported as between 13.67-19.83% by Arvas (2005), as between 16.30 -11.60% by Hınıslıoğlu (1997) and as between 20.66-15.50% by Beyhan (2005). Titratable acidity values were reported as between 1.97-0.43% by Arvas (2005) and as between 0.18-1.88% by Balık (2005).Fruit juice pH values were reported

as between 0.39-1.21 by Bostan (1997), as between 2.90–4.26 by Arvas (2005). Vitamin C contents of *Prunus domestica* L. species were reported as between 5.82-28.42 mg 100 g^{-1} by Yıldız (1996), Cocıu (1993) and Schobinger (1988) reported vitamin C contents as between 2.4-15.2 mg 100 g^{-1}. Soluble solids content of the fruits is a cultivar-specific attribute, but also greatly influenced by altitude. Photosynthetic activity of the trees increase with increasing altitudes, then soluble solids content increases with altitude (Güleryüz 1979). Soluble solids content is directly related to fruit taste and soluble solids are mostly composed of sugars (Karaçalı 1990; Cemeroğlu 1992). Related to taste, plums of Erciş region exhibited a great variation in titratable acidity and pH values. There is a significant relationship between taste and aroma formation and environmental factors. The variations in investigated plum genotypes are mostly related to plant genetics and environmental conditions.

It was concluded based on present findings that Erciş region was quite rich in plum genetic resources, there were plum genotypes with different ripening periods, available trees were not able to fully reflect their yield potentials since they were old and no cared. Among 45 genotypes investigated in this study, the genotypes EES11, EES40, EES17, EES45, EES2, EES48, EES30, EES31, EES36 and EES20were found to be prominent with regard to selection criteria, therefore they were selected as promising genotypes. It was also thought that more successful outcomes could be achieved from the investigated genotypes under better care conditions.

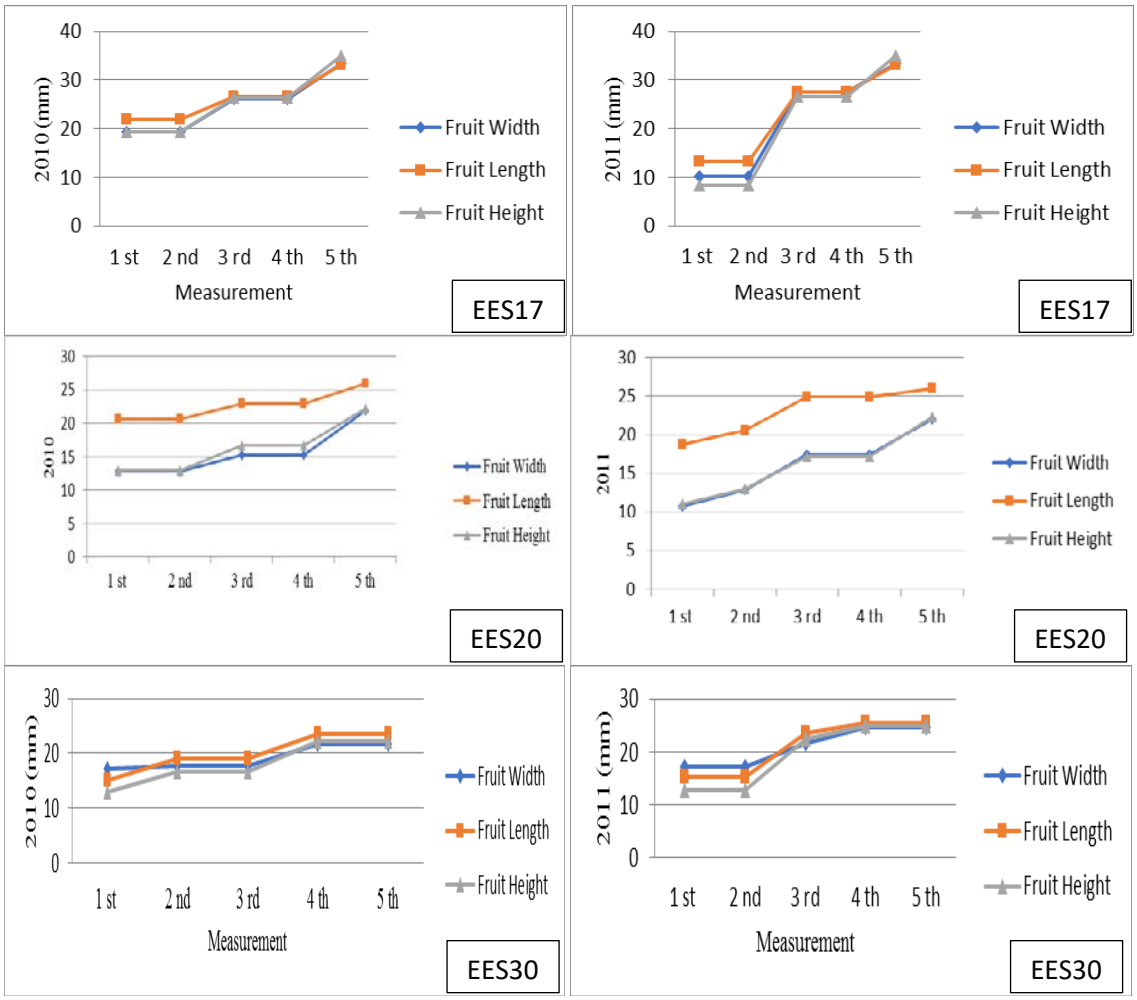

Figure 1. Fruit development curves of promising genotypes

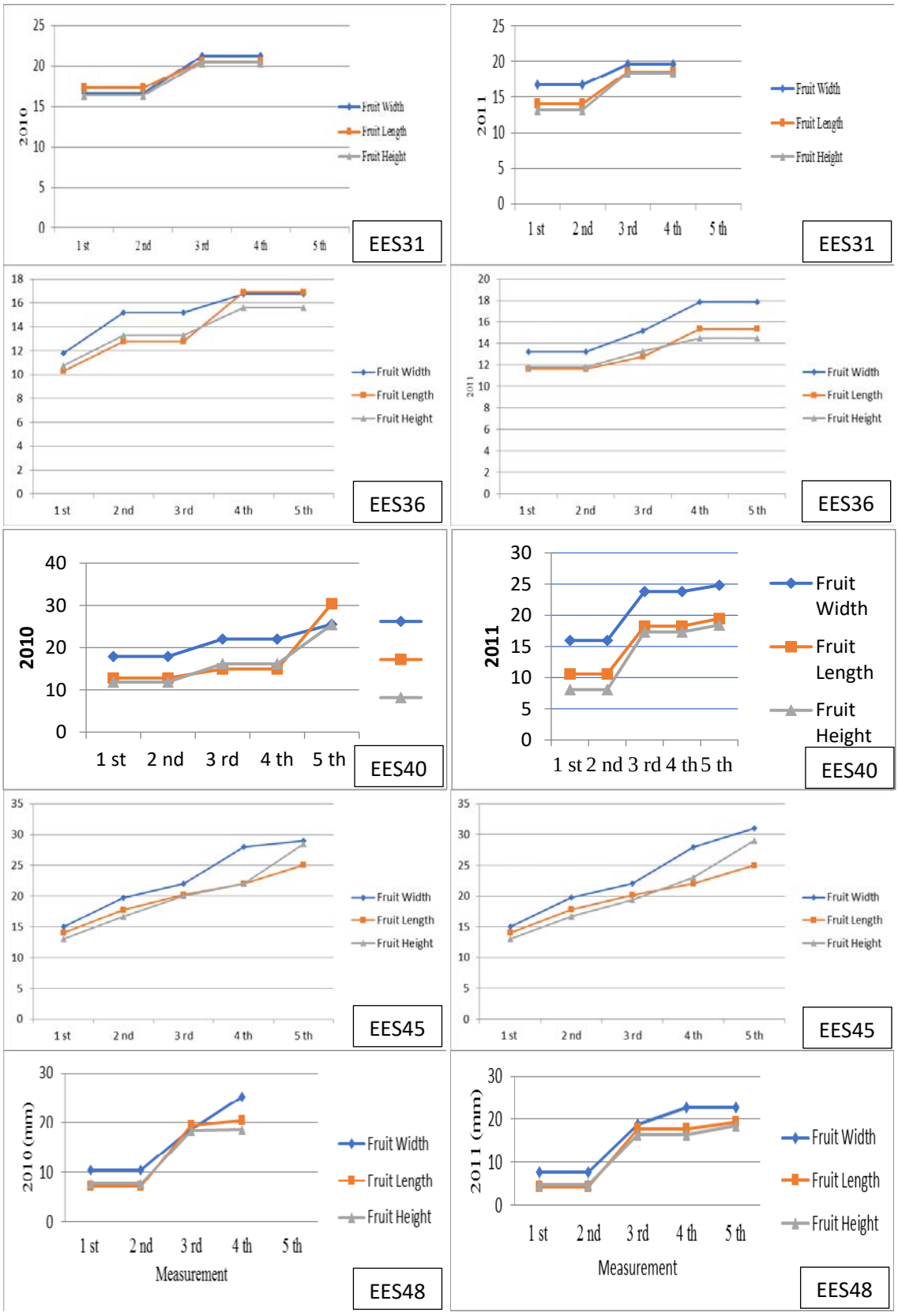

Figure 1. Fruit development curves of promising genotypes (continued)

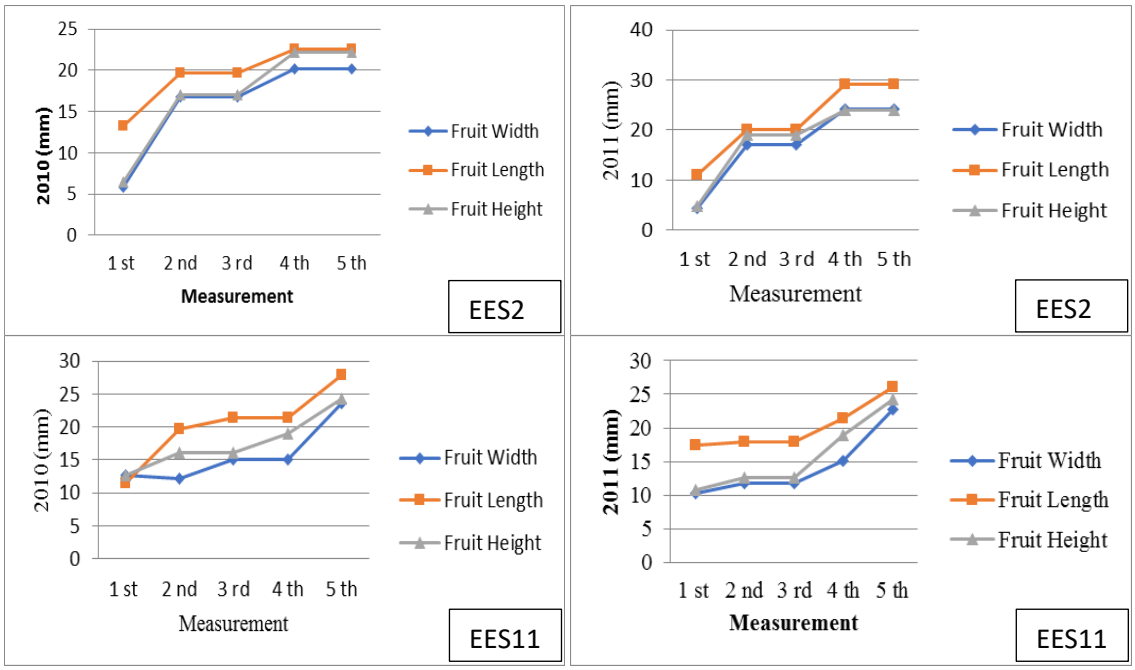

Figure 1. Fruit development curves of promising genotypes (continued)

Table 1. Phenological, pomological, morphological and chemical traits of promising plum genotypes

Investigated Traits	**GENOTYPE**									
Morphological Traits	**EES2**	**EES11**	**EES17**	**EES20**	**EES30**	**EES31**	**EES36**	**EES40**	**EES45**	**EES48**
Canopy width (m)	4.00	4.20	4.50	2.3	3.45	4.50	4.40	2.70	7.4	4.70
Canopy height (m)	2.50	3.00	2.30	2.5	4.20	4.50	4.00	2.50	6	4.00
Canopy shape	Prolate	Semi-vertical	Prolate	Semi-vertical	Prolate	Prolate	Prolate	Vertical	Prolate	Prolate
Phenological Traits										
Bud burst	5 April	26 April	25 April	18 April	18 April	18 April	15 April	26 April	25 April	25 April
Initiation of flowering	7 May	14 May	4 May	7 May	29 April	3 May	30 April	6 May	30 April	7 May
Full-bloom	12 May	17 May	10 May	17 May	5 May	6 May	3 May	11 May	4 May	14 May
End of flowering	22 May	24 May	23 May	22 May	11 May	13 May	11 May	17 May	22 May	20 May
Full-bloom to harvest	81 days	116 days	104 days	114 days	92 days	91 days	90 days	122 days	94 days	116 days
Harvest date	1 August	10 September	5 September	6 September	5 August	5 August	1 August	10 September	6 August	7 September
Seed Traits										
Seed attachment to flesh	Free	Attached	Attached	Attached	Attached	Attached	Attached	Free	Attached	Attached
Seed weight (g)	0.81±0.06	0.84±0.05	0.99±0.12	0.87±0.09	0.89±0.15	1.02±0.07	0.59±0.076	0.75±0.121	1.45±0.23	1.00±0.06
Seed length (mm)	13.31±0.60	19.39±1.59	15.00±0.37	20.97±1.50	14.75±0.75	14.28±0.72	14.86±1.31	17.83±1.57	16.29±2.07	11.91±0.55
Seed width (mm)	12.24±0.42	11.55±0.55	12.44±0.71	12.04±1.08	12.14±1.84	12.47±0.35	9.56±0.63	11.70±0.75	14.31±1.40	19.23±0.71
Fruit Traits										
Fruit weight (g)	14.02±1.92	19.13±1.72	19.28±2.11	11.65±3.03	14.75±3.24	13.51±1.13	8.66±0.77	14.32±2.92	25.59±2.14	16.70±2.44
Fruit shape	Elliptical	Elliptical	Oval	Elliptical	Oval	Oval	Oval	Elliptical	Oval	Elliptical
Fruit length (mm)	34.13±1.45	35.86±1.46	31.07±1.67	30.50±2.09	25.69±1.36	25.89±0.59	22.98±1.38	30.14±2.67	31.25±1.66	32.51±1.67
Fruit width (mm)	28.52±1.30	29.16±1.26	31.00±1.87	23.30±1.73	26.97±2.44	27.11±0.83	22.29±1.36	26.21±2.05	31.22±0.50	26.87±1.77
Fruit height (mm)	30.77±4.09	30.00±1.09	32.43±1.29	24.75±2.59	27.31±2.51	28.48±0.67	23.16±1.22	26.79±2.27	33.32±1.60	29.78±1.34
Fruit volume (mL)	12	17	18	12.8	16	13.4	13.4	15.6	32	15.6
Fruit density (kg/m^3)	1.53	1.13	1.07	0.91	0.92	1.01	1.03	0.92	0.80	1.07
Flesh/stone ratio	17.12±1.10	23.09±1.97	20.06±1.87	11.69±3.02	18.28±1.68	11.50±1.62	13.73±1.28	15.12±3.13	16.10±2.50	14.75±1.47
Skin base color	Yellow	Light red	Red	Light red	Red	Red	Red	Purple	Yellow	Purple
Flesh color	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Red	Green	Yellow	Yellow
Flesh firmness (kg/cm^2)	2.9	1.6	3.3	3	1.8	1.20	1.40	1.9	3	1.7
Aroma	Rich	Moderate	Moderate	Moderate	Poor	Moderate	Rich	Moderate	Rich	Rich
Juiciness	Juicy	Juicy	Juicy	Moderate	Juicy	Juicy	Juicy	Juicy	Juicy	Juicy
Taste	Verywell	Well	Well	Well	Verywell	Well	Verywell	Very well	Verywell	Very well
Fruitfulness	Low	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	High	Moderate
Chemical Traits										
Acidity (%)	0.896	1.8	1.6	1.7	2.62	2.43	1.12	1.38	1.9	1.80
TSSC (%)	15.5	14	10.5	11	13.5	11	13	13.5	14.25	13
pH	4.04	3.86	3.89	3.87	3.75	3.78	4	4.08	3.83	3.81
Vitamin C (mg/100 g)	29.80±0.49	17.20±0.41	13.14±0.53	10.06±0.25	19.06±0.35	15.30±0.18	19.64±0.59	9.84±0.26	25.09±0.73	10.27±0.14

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