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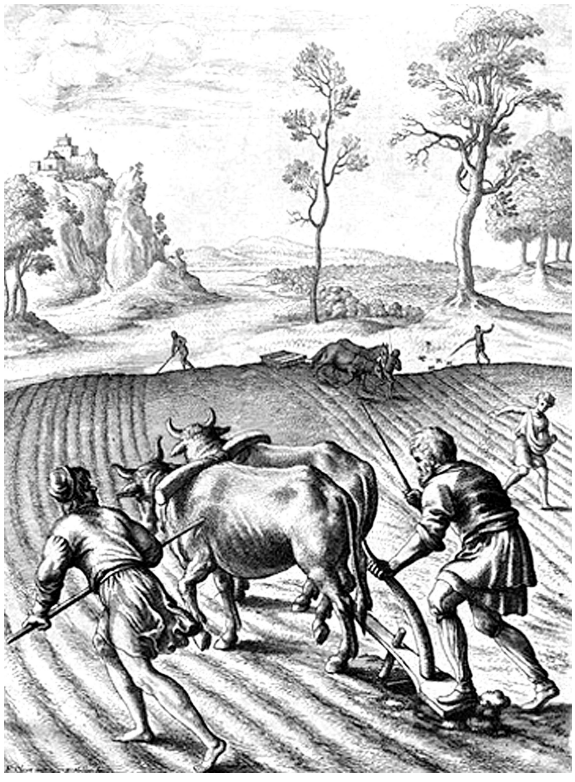

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Selection of Promising Walnut Genotypes in Samsun Province in Turkey

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Abstract: The present study was carried out in Samsun during 1997-2001. Totally 184 genotypes were investigated. The obtained results were evaluated with Weight-Ranked Method. At the end of the evaluation 13 promising walnut genotypes were selected. In the selected genotypes, nut length (34.48-60.42 mm), nut width (30.38-45.24 mm), nut cheek (32.54-47.96 mm), nut size (33.97-50.80 mm), nut weight (11.84-24.19 g), kernel weight (6.39-10.73 g), kernel percent (43.76-60.55%), good kernel percent (81.25-97.92%), shrink kernel percent (1.25-9.38%), defective kernel percent (2.08-18.75%) and shell thickness (0.98-1.65 mm) were determined. Shell color was determined as light for most of the genotypes. Also kernel color was determined as white or light yellow, kernel removal as very easy or easy, shell combination as very strong or strong and kernel roughness determined as smooth, medium or rough.

Key words: *Juglans regia*, walnut, selection

INTRODUCTION

Juglans regia L. is one of the main commercial species scattered around the large parts of the world. Native walnut (*Juglans regia* L.) populations has been present in all parts of the Anatolia and produced for thousands of years (Şen, 1986; McGranahan and Leslie, 1991). Nearly all of the walnut production of Turkey has been provided from walnut trees propagated by seeds. These trees have been found in brook and orchard border or river hillsides. As a result of the effects of using seedling trees for walnut production for hundreds of years, some unique native walnut populations have occurred (Şen, 1986; 1988; Çelebioğlu *et al*., 1988).

Walnut selection studies in Turkey started firstly in Marmara region by Ölez (1971), then followed in North-East Anatolia and East Black Sea region by Şen (1980). And also, the selection studies rapidly increased in some of the local areas in Turkey during recent years (Akça and Şen, 1999a; Kazankaya *et al*., 1999; Sütyemez, 1999; Serdar *et al*., 2001). In the selection studies, some unique walnut genotypes were selected and some of these were registered as a cultivar. Then, walnut growing with these cultivars in mono-crop orchard has just started in Turkey. Moreover, walnut growing in Turkey hasn't been combined with the modern growing techniques (Şen, 1980; Çelebioglu *et al*., 1988; Beyhan *et al*., 1995). This situation can have a negative effect not only on the production and the yield, but also on the exportation because of insufficient crop standardization.

Turkey has approximately 4.5 million walnut trees. Most of these are obtained from seed. Mean walnut production of Turkey is 116,000 tons per year in 1995-2001 and the yield per tree is about 32 kg (Anonymous, 2001). Although, Turkey has very rich source of walnut genotypes and high production, the yield per tree is very low. The walnut selections obtained from different ecological regions have some advantages such as being more suitable to these regions. Samsun province is in Middle-East Black Sea region in Turkey. The region is generally humid and winters are generally temperate. The present study was carried out to the aim of selection of the unique walnut genotypes in Samsun, suitable for the Black Sea Region.

MATERIALS AND METHODS

The present study was carried out for selection of promising walnut genotypes in Samsun province in the Middle-Black Sea region in Turkey during 1997-2001. The promising walnut trees from seedlings were used as material. At the end of the pre-investigation of hundreds of the walnut genotypes, 184 genotypes of these were found to be suitable for investigation. The investigated 184 genotypes were evaluated with Weight-Ranked Method. The determination of selection criterions and constitution of the property classes were performed to Şen (1980). Nut size (mm), nut weight (g), kernel weight (g), kernel percent (%), good kernel percent (%), defective kernel percent (%), shell thickness (mm), shell color, kernel color, kernel removal, shell combination and shell roughness were determined for evaluation in randomly chosen 30 nuts. Class values and class points for each genotype were calculated according to data obtained from

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Table 1: Evaluated nut and kernel properties, coefficients, classes, class values and weight-ranked points

Properties	Coefficients	Classes	Class values (1997-1998 mean)	Points
Nut size (mm)	12	Very high	35.03<	9
		High	32.58-35.03	7
		Medium	30.13-32.57	5
		Low	27.67-30.12	3
		Very low	< 27.67	1
Nut weight (g)	15	Very high	12.91<	9
		High	11.40-12.91	7
		Medium	9.87-11.39	5
		Low	8.85-9.86	3
		Very low	<8.85	1
Kernel weight (g)	10	Very high	6.59<	9
		High	5.68-6.59	7
		Medium	4.77-5.67	5
		Low	3.85-4.76	3
		Very low	<3.85	1
Kernel percent (%)	15	Very high	52.00<	9
		High	47.63-52.00	7
		Medium	43.28-47.62	5
		Low	38.92-43.27	3
		Very low	<38.92	1
Good kernel percent (%)	17	Very high	92.80<	9
		High	85.60-92.80	7
		Medium	78.39-85.59	5
		Low	71.18-78.38	3
		Very low	<71.18	1
Shell thickness (mm)	4	Very thin	1.14>	9
		Thin	1.14-1.39	7
		Medium	1.40-1.66	5
		Thick	1.67-1.92	3
		Very thick	>1.92	1
Shell color	4	Light	1	9
		Brown	2	5
		Dark	3	1
Kernel color	10	White	1	9
		Light yellow	2	7
		Yellow	3	5
		Light brown	4	3
		Dark brown	5	1
Kernel removal	7	Very easy	1	9
		Easy	2	7
		Medium	3	5
		Hard	4	3
		Very hard	5	1
Shell combination	3	Very strong	1	9
		Strong	2	7
		Medium	3	5
		Weak	4	3
		Very weak	5	1
Shell roughness	3	Smooth	1	9
		Medium	2	7
		Rough	3	3

investigated population in 1997-1998 (Table 1). At the end of the evaluation, 13 promising genotypes were selected for advanced studies.

RESULTS

In the present study nut size varied from 24.61-50.80 mm, nut weight varied from 5.31-24.19 g, kernel weight varied from 2.06-10.73 g, kernel percent varied from 30.79-61.64%, good kernel percent varied from 35.00-100.00%, defective kernel percent varied from 0.00-65.00% and also shell thickness varied from 0.83-2.26 mm in evaluated 184 genotypes.

The obtained results of the selected genotypes were given in Table 2. Nut length ranged from 34.48 mm (55-S-63) to 60.42 mm (55-B-18), nut width varied from 30.38 mm (55-S-48) to 45.24 mm (55-B-18), nut cheek varied from 32.54 mm (55-S-48) to 47.96 mm (55-B-18) and also nut shape index varied from 0.99 (55-S-63) to 1.42 (55-Ç-29) in the selected genotypes. Mean nut size of selected genotypes was as high as 50.80 mm (55-B-18) to 33.97 mm (55-S-42). Mean nut weight were ranged from 24.19 g for 55-B-18 to 11.84 g for 55-Ç-30. Mean kernel weight were determined to be between 6.39 g (55-S-42) and 10.73 g (55-B-18) and mean kernel percent varied from 43.76% (55-B-15) to 60.55% (55-M-01) in the selected genotypes.

Table 2: Obtained nut and kernel properties of the selected genotypes (1997-2001*)

Types	NL	NWI	NC	NS	NSI	NW	KW	KP	GKP	SKP	DKP	ST	SC	KC	KR	SCM	SR	TWRP
55-M-01	40.09	33.05	33.51	35.41	1.20	12.04	7.29	60.55	94.16	4.16	5.84	1.03	1	1	1	2	1	864
55-S-44	43.86	32.93	33.32	36.37	1.32	13.28	6.67	50.23	92.91	4.58	7.09	1.43	1	1	1	1	2	848
55-Ç-28	37.20	35.58	36.89	36.55	1.03	14.99	7.95	53.04	88.13	9.38	11.87	1.25	2	1	1	2	1	836
55-S-50	39.32	31.55	34.14	34.86	1.20	12.98	7.00	53.93	90.53	6.97	9.47	1.34	1	2	1	2	1	808
55-Ç-29	45.54	31.24	32.83	36.01	1.42	14.24	7.07	49.65	95.21	4.79	4.79	1.37	2	2	2	1	2	806
55-B-11	40.12	34.25	36.09	36.74	1.14	13.13	6.93	52.78	81.25	8.75	18.75	1.36	1	1	2	1	2	804
55-B-15	42.62	38.87	42.25	41.21	1.05	14.99	6.56	43.76	93.75	1.25	6.25	1.04	1	1	1	1	3	802
55-B-18	60.42	45.24	47.96	50.80	1.30	24.19	10.73	44.36	95.00	5.00	5.00	1.27	1	2	1	1	3	794
55-S-48	41.48	30.38	32.54	34.48	1.32	14.28	6.98	48.88	94.17	3.34	5.83	1.65	1	1	3	2	2	790
55-S-63	34.48	33.44	36.25	34.70	0.99	13.24	6.53	49.32	97.92	2.08	2.08	1.49	1	2	2	1	1	776
55-Ç-30	35.18	33.49	35.06	34.57	1.03	11.84	6.41	54.14	90.00	5.00	10.00	0.98	1	2	1	1	1	772
55-S-42	37.67	31.18	33.36	33.97	1.17	12.21	6.39	52.33	87.55	5.53	12.45	1.28	1	2	1	2	1	758
55-Ç-16	38.25	31.29	33.06	34.08	1.19	12.28	6.92	56.35	88.75	2.09	11.25	1.33	1	3	2	2	1	744

NL: nut length (mm), NWI: nut width (mm), NC: nut cheek (mm), NS: nut size (mm) ($\sqrt[3]{}$NL*NWI*NC), NSI: nut shape index (NL/[NWI+NC/2]), NW: nut weight (g), KW: kernel weight (g), KP: kernel percent (%), GKP: good kernel percent (%), SKP: shrink kernel percent (%), DKP: defective kernel percent (%), ST: shell thickness (mm), SC: shell color (1: light, 2: brown, 3: dark), KC: kernel color (1: white, 2: light yellow, 3: yellow, 4: light brown, 5: dark brown), KR: kernel removal (1: very easy, 2: easy, 3: medium, 4: hard 5: very hard), SCM: shell combination (1: very strong, 2: strong, 3: medium, 4: weak, 5: very weak), SR: shell roughness (1: smooth, 2: medium, 3: rough). TWRP: total weight ranked point. * Samples didn't evaluated in 2000

The highest good kernel percent was 97.92% in 55-S-63, the lowest was 81.25% in 55-B-11. Additionally, the lowest shrink kernel percent was determined to be 1.25% in 55-B-15, the highest was determined to be 9.38% in 55-Ç-28 and the highest defective kernel percent was 18.75% in 55-B-11 and the lowest was 2.08% in 55-S-63. The lowest shell thickness was 0.98 mm in 55-Ç-30, the highest was 1.65 mm in 55-S-48.

Shell color was determined as light in selected 11 genotypes except for two genotypes (55-Ç-28 and 55-Ç-29 were brown). Kernel color was determined as white in the selected 6 genotypes, as light yellow in the 6 genotypes and as yellow only one genotype (55-Ç-16). Kernel removal was very easy in the 8 genotypes, easy in the 4 genotypes and medium in the 55-S-48. Shell combination of the selected 7 genotypes were very strong, the other 6 genotypes were strong. The shells of selected 7 genotypes were smooth, 4 genotypes were medium and the other two (55-B-15 and 55-B-18) were rough. The highest total weight-ranked point was 864 in 55-M-01 and the lowest was 744 in 55-Ç-16.

DISCUSSION

Kernel percent is one of the most important characteristic for breeding objectives. In the selected walnut genotypes, kernel percent ranged between 43.76 and 60.55%. To the previous findings, kernel percent of some important walnut cultivars (Table 3) varied from 40.00% (Kaplan) to 64.14% (Şebin). When the selected genotypes compared the cultivars, kernel percents of the genotypes are higher than many of these. Kernel percent is closely related to shell thickness. Kaşka (2001) recommends that the kernel percent should be maximum 55% for protection of birds and harvest damages because of thin shells of the nuts. In the present study two types (55-M-01 and 55-Ç-16) have higher kernel percent than 55%. Despite higher kernel percents, shells of the types were sufficiently thick, strong and firmly closed as in all the other selected genotypes in the present study.

Nut weight and kernel weight are two important selection characteristics for walnut breeding. Heritability of the nut weight and kernel weight are high (respectively 0.86 and 0.87) (Forde and Mcgranahan, 1996). Higher nut and kernel weights are desirable for higher yield. Nut weights of the selected genotypes varied from 11.84 to 24.19 g and kernel weights varied from 6.39 to 10.78 g. It is recommended (Şen, 1986; Kaşka, 2001) that the lowest nut and kernel weights should be 10 and 5 g, respectively for walnut selection. Up to now, in Turkey, nut weights of the previous selections determined between 5.38 and 21.80 g and kernel weights determined between 2.61 and 10.10 g (Ölez, 1971; Akça and Şen, 1999a, 1999b; Akça *et al*., 1999; Ayanoğlu and Bayazit, 1999; Kazankaya *et al*., 1999; Sütyemez, 1999; Yarılgaç *et al*., 1999). As seen the results, most of the selected genotypes have as high as nut and kernel weights of previous selections and some of the important cultivars (Table 3). Besides, 55-B-18 genotype has the highest nut and kernel weights, compared with both the important cultivars and the previous selections. This unique genotype can be used for further breeding studies and investigations. On the other hand, this genotype has the highest nut size (50.80 mm).

Good kernel percent is one of the most important quality characteristic for marketing. Heritability of the good kernel percent is absolutely low (-0.08) (Forde and Mcgranahan, 1996). This character is affected easily by ecological conditions. In this research, good kernel

Table 3: Nut weight, kernel weight and kernel percent of some important walnut cultivars (McGranahan and Leslie, 1991; Akça, 1999)

	Payne	Hartley	Franquet	Chiko	Sunland	Vina	Chandler	Pedro	Cisco	Kaplan	Yalova-2	Bilecik	Sebin
NW (g)	11.5	14.0	11.6	10.9	17.5	12.8	12.9	12.1	12.3	24.0	17.39	10.23	11.36
KW (g)	5.7	6.4	5.2	5.0	9.9	6.3	6.4	5.6	5.6	9.2	8.75	5.73	7.44
KP (%)	50.0	46.0	45.0	46.0	57.0	49.0	50.0	46.0	46.0	40.0	50.37	56.01	65.14

percent of the selected genotypes ranged between 81.25 and 97.92%. On the contrary, defective kernel percent (include shrinks) is ranged between 2.08 and 18.75% in the selected types. Low defective kernel is desirable for walnut cultivars and types. Some of the selected types have higher defective kernels. An important reason of higher defective kernel can be unsuitable growing techniques.

Shell thickness is an important factor for walnut breeding studies. Kernel percentage changes according to the shell thickness of the walnut genotypes. Thin shells increase the kernel percents. Heritability of shell thickness is 0.91 (Forde and Mcgranahan, 1996). In this research, shell thickness of the selected genotypes determined between 0.98 and 1.65 mm. In the previous selection researches, shell thickness varied between 0.86-1.75 (Yarılgaç *et al*., 1999), 1.00-2.10 (Kazankaya *et al*., 1999), 1.32-2.45 (Akça and Şen, 1999a), 0.91-1.76 (Akça and Şen, 1999b). Shell thickness is essential for saving kernels from the external effects. It was stated earlier that the shells of selected types were adequately thick and similar the shell thickness of the previous selections.

Shell color, kernel color, shell combination and kernel roughness other important characters for selection of walnut. Shell color was determined as light for most of the genotypes. Also kernel color was determined as white or light yellow, kernel removal as very easy or easy, shell combination as very strong or strong and kernel roughness determined as smooth, medium or rough.

As a result, the selected 13 genotypes appear promising with some unique properties for further investigations. For instance, 55-M-01 genotype is unique for higher kernel percent, good kernel percent and lower shell thickness and 55-B-18 is unique for nut size, nut and kernel weight. Otherwise, the selected genotypes can be suitable for humid and temperate regions as in the Black Sea region.

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