Evaluation of Some Avocado Cultivars under El-Nubaria Region Conditions

Laila Y. Mostafa and Samia S. Hosney

Tropical Fruit Research Department, Horticulture Research Institute,
Agricultural Research Centre, Giza, Egypt

Abstract: The present investigation was conducted during 2018 and 2019 seasons on 20 years old of avocado (*Persea Americana* Millers) cultivars namely Hass, Bacon, Fuerte, Reed and Ettinger grown at Al-salmaia orchard at El Nubaria region, El-Beheira governorate, Egypt. Date of flowering, flowering type, fruit skin surface, fruit shape, fruit set % and yield as well as physical and chemical properties of fruit and economic and numerical evaluation were determined for all tested avocado cultivars. Results indicated that date of flowering and fruit set percentage varied between tested cultivars. Reed avocado cultivar gave the ideal values of physical fruit properties which produced the highest fruit diameter, fruit weight, seed weight, pulp weight and pulp %. Among the chemical fruit properties are V.C%, DM %, oil % were the highest in Fuerte cultivar , Reed gave the highest percentage of TSS, while Hass recorded the lowest percentage of acidity. The economic and numerical evaluation of all tested avocado cultivar showed that they were ranked as follows; Reed, followed by Fuerte, Ettinger, Bacon and finally, Hass cultivars. Generally, the obtained results proved that Reed, Fuerte and Ettinger performed better, those that had been grown in EL-Nubaria region, EL-Beheira governorate, Egypt, for its high in yield and fruit quality comparing to the other tested avocado cultivars.

Key words: Avocado · Yield · Fruit quality · Economic evaluation · Numerical evaluation

INTRODUCTION

Avocado (*Persea Americana* Millers) are native to Mexico and Central America but are now grown in many different regions across the globe [1]. The estimated total world production for avocados in 2016 was 5.567.044 tons and the production area was 563916 hectares. Mexico, was the largest producer, account for 34% of global production [2]. The avocado tree is an evergreen that attains heights of 20m, has many branches and produces edible fruits.

Fruit is very much appreciated and it occupies a prominent place in the market due its high nutritional value, especially fibers and lipids. In addition, it has soft flavor and low sugar content (about 10gm / kg of pulp) and is generally recommended for the diabetic, suffering people since it is a high-energy food [3]. Avocado fruit shows great variability in size, shape, weight and chemical composition depending on variety, the climate conditions and the agricultural practices [4].

Avocado fruit has a very high value, not only from the nutritional side, but also for its role in the cosmetic and health industries. The mesocarp contains enormous amounts of vitamins A, C and E, while the pericarp contains fixed oils, which are usually considered as efficient components of any healthy antioxidant diet [5].

In horticulture, avocado plants are classified into three group or races, which are: Mexican, Guatemalan and West Indian [6]. Mexican race is well adapted to highland and cold resistance, smooth, glossy and has thin peel, a big seed and Loose in cavity, a small fruit with high fat content and peanut test. Guatemalan race is adaptable to highlands and cold resistance; thick and commonly rough, woody stiff peel, small seed, tight in cavity; large fruit long ripening time and high savory nut flavour. West Indian race is adapted to low land and not resistance to cold, has smooth and elastic-like leather, green, yellowish-reddish colour, big seed with rough cotyledon surface and loose in cavity, medium fruit size with low fat content [7, 8]. The avocado race most

---

Corresponding Author: Laila Y. Mostafa, Tropical Fruit Research Department, Horticulture Research Institute,
Agricultural Research Centre, Giza, Egypt.

commonly found in Indonesia is West Indian, although there are some plants that had resulted from crossing with the Guatemalan or the Mexican race. The most important cultivar currently in production is "Hass" and has been described as 85% Guatemalan and 15% Mexican [8]. Fuerte, which is about half and half Mexican-Guatemalan, Bacon which is predominantly a Mexican hybrid with Guatemalan, while Ettinger cultivar is described as a Mexican race. Cultivars fall into one of two pollination types, referred to as type A and type B, the difference lying in the time of day (morning vs. afternoon) that the male and female flowers are capable of reproducing flowers. Type A cultivars (Hass and Reed) open in the morning as receptive females, then close in the afternoon until the following afternoon, when they reopen for pollen shed. Type B avocado flowers (Bacon, Fuerte and Ettinger) open in the afternoon as receptive females, close overnight and reopen the following morning to shed pollen [9]. The main objective of this investigation is to study the morphological description and evaluation of five avocado cultivars namely: Hass, Bacon, Fuerte, Reed and Ettinger to determine the adaptability to environmental conditions under Nubaria, El-Beheira Governorate, Egypt.

MATERIAL AND METHODS

The present investigation was conducted in AL-Salamia orchard (Latitude: 30.69863 and Longitude: 30.02922), at El-Nubaria region, El-Beheira Governorate, Egypt, during two successive seasons 2018 and 2019. The trees in the orchard were grown in sandy soil at 6×7m apart and subjected to drip irrigation system. Twenty avocado trees uniform as possible as can in shape, vigors, size and productivity were selected to conduct this experiment. Five cultivars were studied Hass, Bacon, Fuerte, Reed and Ettinger with four replicate per cultivar. Soil samples were taken at 0-30cm, 30-60cm and 60-90cm form soil surface for chemical analysis and the data are shown in Table (1).

The following topics were studied and recorded: Date of flowering, flowering type, fruit skin surface and fruit shape were recorded following IPGRI [10].

Fruit Set %: At harvest time, the percentage fruit set was calculated using the following equation:

$$\frac{\text{Total number of fruit set/panicle}}{\text{Number of flowers /panicle}} x100$$

Total number of fruits per tree was collected at harvest time of each cultivar, then yield was determined as kg/tree (total number of fruits/tree × average fruit weigh (g)/100).

Fruit Physical Properties: Samples of five fruits from each branch were collected at maturity stage to estimate fruit length (cm), fruit diameter (cm), fruit weight (g), seed weight (g), pulp weight (g) and pulp (%).

Fruit Chemical Properties: Total soluble solids (TSS%) was determined by using a digital refractometer Model 10430, Bausch and Lomb co. Calif., USA), method described according to Jha *et al.* [11]. Total acidity was determined by titrating 5ml Juice with 0.1N sodium hydroxide using phenol phthalein as an indicator. V.C mg/100 gm) was determined as ascorbic acid content using 2.5-6 dichlorophenol indophenols' titration methods as described by A.O.A.C. [12]. Oil % in flesh was determined using the Soxhlet method, using petroleum ether as the extraction solvent [13]. Dry matter (DM): analysis was conducted according to Lee and Coggins [14].

General Evaluation of Tested Trees of Avocado: The final evaluation of tested trees was calculated on the basis of 100 units which were shared between yield (30 units) and fruit quality (70 units) according to IPRG [10] and Lestari *et al.* [15]. The latter units were divided on the basis of 10 units for the percent of each tendency to produce stable yield, TSS and acidity content, oil % and dry mater, beside the fruit weight and pulp % and 5 units for each of fruit length and fruit diameter. Each cultivar that gave the best result in any property took the full mark specified for this property, while each of the other tested cultivar took lower units equal to their quality.

Economic Evaluation of Some Avocado Cultivars Production Was Estimated: According to Radinovic *et al.* [16] as average during two experimental seasons.

Statistical Analysis: The obtained data were subjected to analysis of variance in randomized complete block design according to Snedecor and Cochran [17]. The averages were compared by using the method of new least significant differences (New L.S.D.) described by Waller and Duncan [18].

Table 1: Chemical analysis of soil orchard.

Depth	pH	Ec ds/m	Na^+	K^+	Ca^{++}	Mg^{+2}	CL^-	HCO_3^-	SO_4^{-2}
0-30cm	7.89	1.54	5.70	1.0	8.0	5.0	2.5	2.0	10.9
30-60 cm	8.0	1.60	5.30	1.1	7.5	6.3	2.20	1.90	10.2
60-90 cm	7.92	1.62	4.85	0.95	8.2	5.20	3.2	2.20	10.5

RESULTS AND DISCUSSION

Date of flowering, flowering type, fruit surface and fruit shape were assessed and tabulated in Table (2). It is clear that under conditions of El-Nubaria region, El-Beheira Governorate, date of flowering of all avocado cultivars under evaluation started with the flowering stage in duration of 30th Dec. to 30 thMarch and ended in duration 1st April to 1 stMay throughout these two seasons under investigation. Based on the flowering pattern and IPGR, [10] guidance, Hass and Reed cultivars revealed an A flower type, while Bacon, Fuerte and Ettinger presented a B flower type Table (2).

Regarding fruit surface Table (2) and Fig. (1), the data revealed that Bacon and Ettinger cultivars showed a smooth surface, Fuerte and Reed showed a medium surface, while the Hass cultivar showed a very rough fruit surface. The data also, cleared that fruit shape in Fuerte and Ettinger cultivars had a pyriform shape, Hass and Bacon had an ovate shape, while Reed cultivar showed a round fruit shape Table (2) and Fig. (1).

Data presented in Table (3) indicated that percentage of fruit set differed significantly among cultivars under study. The highest percentage (17.40 and 18.30%) of fruit set recorded was for Hass cultivar in 2018 and 2019 seasons, while the lowest value was observed for Bacon cultivar (11.70 and 11.0%) in the first and second seasons, respectively. The other remaining avocado cultivars gave intermediate values with significant differences amongst them. Similar results were obtained by Bender [19].

Regarding an average of the total number of fruits per tree and fruit yield (kg/tree), data in Table (3) cleared that Reed and Hass cultivars recorded maximum number of fruits per tree. However the lowest number of fruits per tree recorded was by Bacon cultivar. The highest fruit yield weight (kg) was produced from Reed avocado cultivar (58.60 and 63.37 kg) in 2018 and 2019 seasons, while Hass cultivar gave the lowest values (19.68 and 21.30 kg). The highest fruit yield was associated with increasing the number of fruits, higher fruit set, fruit weight and fruit growth. The above results are in agreement with Bayram *et al.* [20] and Islam and Alkfrawey [21] who'd noted that there were wide and great variations on fruiting characteristics of most avocado cultivars.

The physical properties of the avocado fruits were assessed in the current study (Table 4). In 2018 and 2019 seasons, Ettinger avocado recorded the tallest fruit (12.5 cm and 11.8 cm) with the lowest diameter (6.7 and 6.1 cm). Reed cultivar had the heaviest fruit weight (390.0 and 395.3 gm) with the highest pulp weight (323.7 and 328.1 gm), seed weight (66.3 and 67.2 gm) and highest percentage of pulp (83.2 and 83.0%, respectively). Reed was the superior cultivar, which had the highest physical fruit properties. Ayala-Silva *et al.* [1] noted that fruit quality impacts the market value, as fruit size and shape are important physical attributes in sorting, sizing, packaging and transporting fruits. Likewise, Ayala-Silva *et al.* [22] reported that, seed size is very important in any fruit for consumption. Consumers prefer fruits with a small seed and large pulp content.

Significant differences were observed in fruit chemical properties (Table 5) that were produced from different cultivars, grown in El-Nubaria region through 2018 and 2019 seasons. It is evident from the foregoing results that the Reed, Fuerte and Ettinger cultivars gave the highest values of TSS and V.C while Hass cultivar recorded the lowest value of TSS and acidity. Fuerte cultivar recorded the highest value of V.C, DM and oil content. On the other hand, Reed cultivar recorded the lowest value in V.C, DM and oil percent in both season. These results are similar to those of Bayram *et al.* [20] and Arpaia *et al.* [23] the latter reported that avocados have a measurable relationship between percent dry matter and physiological maturity of avocados. The use of the percent dry matter as a maturity indicator for avocado is widely accepted. Ozdemir and Topuz [24], revealed that minimum oil content necessary for marketing avocado fruit is 8% after maturation, values greater than 20% can occur. These values occur in the period between harvesting, when commercial maturity is reached and full maturation, when the oil content increases and change occurs in the oil composition. Ranney *et al.* [25] reported that, most avocado producing countries set a minimum maturity standard to ensure unacceptably immature fruits are not marketed. The minimum maturity standards based on percent dry matter developed for California are Bacon, 18.5% Fuerte, 19.9%; Hass, 21.6% and Reed, 19.8%.

Table 2: Date of flowering, flowering type, fruit surface and fruit shape of five avocado cultivars grown in El-Nubaria region in 2018 and 2019 seasons

Avocado cultivars	Flowering Period		Flowering type	Fruit surface	Fruit shape
	2018	2019			
Hass	30th Mar - 1st May	25th Mar - 1stMay	A	Very rough	Ovate
Bacon	1st Feb - 1st April	5th Feb - 7th April	B	Smooth	Ovate
Fuerte	30th Dec - 15th April	5th Jan - 20th April	B	Medium	Pyriform
Reed	15th Feb - 25th April	20th Feb - 30th April	A	Medium	Round
Ettinger	15th Jan - 1st April	20th Jan - 5th April	B	Smooth	Pyriform

Table 3: Fruit set %, number of fruit per tree and fruit yield (kg) of five avocado cultivars grown in El-Nubaria region in 2018 and 2019 seasons

Avocado cultivars	Fruit set %	No. fruit/ tree	Yield (kg)	Fruit set %	No. fruit/ tree	Yield (kg)
	2018			2019		
Hass	17.40	164.0	19.68	18.3	170.0	21.30
Bacon	11.70	86.0	22.03	11.0	85.0	21.85
Fuerte	15.20	98.30	29.50	13.30	95.3	28.70
Reed	13.80	150.2	58.60	15.20	160.3	63.37
Ettinger	14.50	95.0	26.98	13.50	90.2	25.73
New L.S.D 0.05	0.78	65.5	0.34	0.49	1.06	0.84

Table 4: Physical fruit properties of five avocado cultivars grown in El-Nubaria region in 2018 and 2019 seasons.

Avocado cultivars	F. length (cm)	F. diameter (cm)	Fruit weight (gm)	Seed weight (gm)	Pulp weight (gm)	Pulp%
			2018			
Hass	8.9	5.9	120.0	22.5	97.5	81.3
Bacon	11.2	7.1	256.0	48.2	207.8	81.2
Fuerte	12.0	7.0	300.4	50.4	250.0	83.0
Reed	10.3	8.3	390.0	66.3	323.7	83.2
Ettinger	12.5	6.7	284.0	59.0	225	79.2
New L.S.D 0.05	0.51	0.80	48.3	0.56	0.98	0.43
			2019			
Hass	8.8	5.8	125.3	23.6	101.7	81.4
Bacon	10.9	7.0	257.0	48.8	208.2	81.0
Fuerte	11.5	6.5	301.2	52.7	248.5	82.5
Reed	10.1	8.3	395.3	67.2	328.1	83.0
Ettinger	11.8	6.1	285.2	57.0	228.2	80.0
New L.S.D 0.05	0.54	0.51	0.98	0.51	0.53	0.69

Table 5: Chemical fruit properties of five avocado cultivars grown in El-Nubaria region in 2018 and 2019 seasons

Avocado cultivars	TSS%	Acidity%	V.C mg/100gm	DM%	Oil%
			2018		
Hass	7.86	0.87	10.46	26.53	14.73
Bacon	8.08	1.03	9.04	24.32	14.43
Fuerte	8.20	1.02	12.23	29.43	18.10
Reed	9.90	0.94	9.02	19.02	8.30
Ettinger	9.30	0.88	10.20	27.30	15.52
New L.S.D 0.05	0.41	0.01	0.24	0.30	0.53
			2019		
Hass	7.50	0.90	9.80	24.30	14.20
Bacon	8.03	1.30	7.30	23.30	13.20
Fuerte	9.02	0.95	11.30	27.30	16.04
Reed	8.50	1.0	9.80	17.03	9.20
Ettinger	9.50	0.87	10.20	26.40	14.30
New L.S.D 0.05	0.22	2.30	0.63	0.29	0.47

Table 6: General score evaluation of five avocado cultivars grown in El-Nubaria region in 2018 and 2019 seasons

Index	Units specified	Hass	Bacon	Fuerte	Reed	Ettinger
			2018			
Yield (kg)	30	10.08	11.28	15.10	30	13.80
Fruit set %	10	10	6.72	8.74	7.93	8.33
Fruit weight (gm)	10	3.08	6.56	7.70	10	7.28
Pulp %	10	9.77	9.76	9.97	10	9.52
Fruit length (cm)	5	3.56	4.48	4.80	4.12	5
Fruit diameter (cm)	5	3.55	4.28	4.22	5	4.04
Seed weight (gm)	5	1.70	3.63	3.80	5	4.45
Oil %	10	8.14	7.97	10	4.59	8.57
Dry matter %	5	4.5	4.13	5	3.23	4.64
TSS%	5	3.97	4.08	4.14	5	4.70
Acidity%	5	4.22	5	4.95	4.56	4.27
Total score Fruit quality	70	52.49	56.61	63.32	59.43	60.8
Total unit yield/cultivar	100	62.57	67.89	78.42	89.43	74.6
			2019			
Yield (kg)	30	10.08	10.34	13.59	30	12.18
Fruit set %	10	10	6.0	7.27	8.31	7.38
Fruit weight (gm)	10	3.16	6.5	7.62	10	7.20
Pulp %	10	9.80	9.76	9.94	10	9.64
Fruit length (cm)	5	3.73	4.62	4.87	4.28	5
Fruit diameter (cm)	5	4.0	4.22	3.9	5	3.70
Seed weight (gm)	5	1.76	3.63	3.92	5	4.24
Oil %	10	8.85	8.23	10	5.74	8.92
Dry matter %	5	4.45	4.27	5	3.12	4.84
TSS%	5	3.95	4.23	4.75	4.47	5
Acidity%	5	4.61	5	3.65	3.85	3.35
Total score Fruit quality	70	54.31	56.46	60.92	59.77	59.27
Total unit yield/cultivar	100	64.39	66.8	74.51	89.77	71.45

Table 7: Economic evaluation of five avocado cultivars grown in El-Nubaria region in 2018 and 2019 seasons

				Total return (E.P./fed)		
Avocado cultivars	Average fruit yield weight (kg/tree)	Average fruit yield weight (ton/fed)	Price/kg	Total income	Operation cost of management	Net income
Hass	20.49	2.04	30	61200	1000	60200
Bacon	21.94	2.19	40	87600	1000	86600
Fuerte	29.1	2.91	40	116400	1000	115400
Reed	60.99	6.09	40	243600	1000	242600
Ettinger	26.36	2.64	40	105600	1000	104600

Numerical Evaluation: Total score of yield and fruit quality (100). Data pertaining the general evaluation of the avocado cultivars in Table (6) revealed that Reed cultivar seemed to be the highest in yield and fruit quality (89.43 and 89.77 unit) in 2018 and 2019 seasons followed by Fuerte cultivar (78.42 and 74.51 unit) and Ettinger cultivar (74.6 and 71.45 unit) while, the lowest general evaluation score was recorded by Hass cultivar (62.57 and 64.39 unit) followed by Bacon cultivar (67.89 and 66.8 unit, respectively).

The tested cultivars could be arranged descendingly, based on total score (70) for fruit quality as follows: Fuerte (63.32 and 60.92 unit), Ettinger (60.8 and 59.27 unit) Reed (59.43 and 59.77 unit), Bacon (56.61 and 54.31 unit), Hass (52.49 and 54.31 unit) in both seasons. In accordance with the present results, those

obtained by Demirkol *et al*. [26]; Ranney *et al*. [25] and Underraga *et al*. [27].

The obtained data clearly showed that Reed, Fuerte, Ettinger and Hass performed better and could be recommended to be grown in El-Nubaria region-El-Beheira governorate, for they are high in yield and fruit quality, as compared with other tested avocado cultivars.

Economic evaluation of some avocado cultivars grown in El-Nubaria region El-Beheira governorate, as average during two successive seasons, (Table 7) has revealed that net income in some cultivars could be arranged descendingly as follows: Reed, Fuerte, Ettinger, Bacon and Hass. The minimum value of net income is shown in Hass and Bacon cultivars, while the maximum value is shown in Reed and Fuerte cultivars.
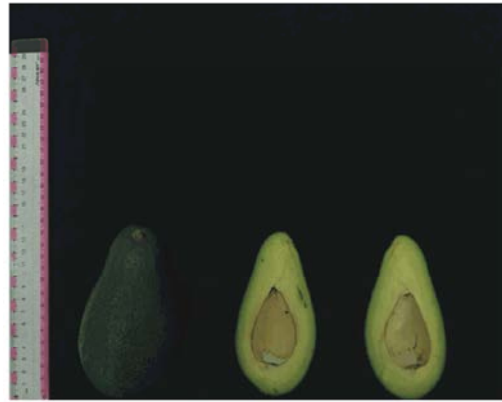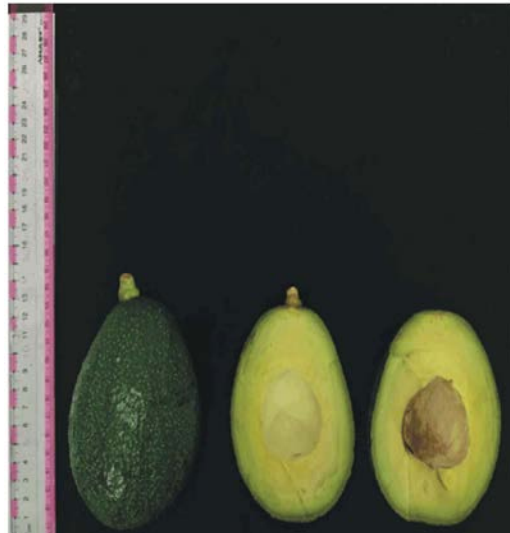
Bacon avocado cv.   Hass avocado cv.

Fuerte avocado cv.   Reed avocado cv.

Ettinger avocado cv.

Fig. 1: Fruits shape and surface of the evaluated avocado cultivars

REFERENCES

1. Ayala-Silva, T. and N. Ledesma, 2014. Avocado history, biodiversity and production. In:Sustainable Horticultural Systems: Issues, Technology and Innovation (pp: 157-205). DOI: 10.10007/978-3-319-06904-3_8.

2. FAOSTAT, 2018. Crop Production, Statistics score units of fruit quality. Division, Food and Agriculture Organization of the United Nations. Rome http://faostat.fao.org.

3. Pino, J.A., R. Marbot, A. Rosado and V. Fuentes, 2004. Volatile components of avocado (*Persea americana* Mill.) cv. Moro grown in Cuba. Journal of Essential Oil Research, 16(2): 139-140. http://dx.doi.org/10.1080/10412905.2004.9698676.

4. Sinyinda, S. and J.W. Gramshaw, 1998. Volatiles of avocado fruit. Food Chemistry, 62(4): 483-487. http://dx.doi.org/10.1016/S0308- 8146(97)00190-8.

5. Bergh, B., 1992. Nutritious Value of Avocado, California. Avocado Society Yearbook, 76: 123-135.

6. Morton, J., 1987. Laureaceae. In J. F. Morton. Fruits of warm climates. Miami: Morton, pp: 91-102.

7. Popenoe, W., 1974. Manual of tropical and subtropical fruits. Hafner Press. A Division of Macmillan Publishing Co., Inc. New York, pp: 474.

8. Bergh, B. and N. Ellstrand, 1986. Taxonomy of the Avocado. California Avocado Society Year Book, 70: 135-146.

9. Schaffer, B., B.N. Wolstenholme and A.W. Whiley, 2013. The avocado: Botany, productionand uses. 2nd Edition. CAB International Press, Wallingford, U.K. Page: xi+ 540.

10. IPGR, 1995. Descriptors for avocado (*Persea spp.*). International Plant Genetic Resources Institute, Rome, Italy.

11. Jha, S.N., A.R.P. Kingsly and S. Chopra, 2006. Physical and mechanical properties of mango during growth and storage for determination of maturity. J. Food Eng., 72: 73-76.

12. A.O.A.C., 1990. Official methods of analysis of the 5th ed published by Association of Official Analytical Chemists. 5th ed published by Association of Official Analytical Chemists. Washington, DC. U.S.A.

13. Lee, S.K., 1981. Methods for percent oil analysis of avocado fruit. California Avocado Society Yearbook, 65: 133-141.

14. Lee, S.K., C.W. Coggins and Jr 1982. Dry weight method for determination of avocado fruit maturity. California Avocado Society Yearbook, 66: 67-70.

15. Lestari, R., L.A. Sukamto, P. Aprilianti, S. Wahyuni and W.U. Putri, 2016. Selection of avocado plantsbased on fruit characters, fat content and continual harvest along the year in West Java-Indonesia. International Journal on Advanced Sci. Eng. Information Technology, 6(1): 77-83.

16. Radinovic, S., J. Gugic and Z. Grgic 2004. Economic Efficiency of Olive Growing. Agriculturae Conspectus Scientificus, 69(4): 115-120.

17. Sendecor, G.W. and W.G. Cochran, 1980. Statistical Methods. Oxford and J.B.H. Publishing Com., 6th edition.

18. Waller, R.A. and D.B. Duncan, 1969. A buyes rule for the symmetric multiple comparison problems. Amer. state. Assoc. J., 64: 1484-1503.

19. Bender, G.S., 2012. Avocado Botany and Commercial Cultivars Grown in California. In Book 1. Avocado Production in California A Cultural Handbook for Growers Second Ed.

20. Bayram, S., M.A. Arslan, E. Turgutoglu and M. Erkan, 2012. The performance of some avocado cultivars under Mediterranean costal conditions in Turkey. J. Food Agri. & Env., 10(2): 588-592.

21. Islam, S.E. and A.A.M. Al-Kfrawey, 2018. Studies on hybridization between two cultivars of avocado Fuerte and Hass and their effect on fruit characteristics. Middle East J. Appl. Sci., 8(2): 370-381.

22. Ayala-Silva, T., R.J. Schnell, A.W. Meerow, A.W. Winterstein, M.C. Cervantes-Martinez and J.S. Brown, 2005. Determination of color and fruit traits of half-sib families of mango (*Mangifera indica* L.). Proceedings of Florida State Horticultural Society, 118: 253-257.

23. Arpaia, M.L., D. Boreham and R. Hofshi, 2001. Development of a new method for measuring minimum maturity of avocados. California Avocado Society Yearbook, 85: 153-178.

24. Ozdemir, F. and A. Topuz, 2004. Changes in dry matter, oil content and fatty acids composition of avocado during harvesting time and post-harvesting ripening period. Food Chemistry, 86: 79-83.

25. Ranney, C.A., G. Gillette, S. Brydon, A. Mcintyre, O. Rivers and C.A. Vasquez, 1992. Physiological maturity and percent dry matter of California avocado. Proceeding of Second World Avocado Congress, pp: 379-385.

26. Demirkol, A., S. Bayram and I. Baktir, 2004. Adaptation and performance of 15 avocado cultivars grown in Antalya province in southern Turkey. Proc. XXVI. IHC-Citrus; Subtropical and Tropical Fruit Crops. Acta Horticulturae, 632: 45-52.

27. Underraga, P., J. Oleata and F. Gardiazaba, 1987. Seasonal changes on chemical and physical parameters in six avocado (*Persea Americana* Mill.) cultivars grown in Chile. South African Gowers' Association Yearbook, 10: 138-140.