Journal of Applied Horticulture, 13(2): 96-100, 2011

Systematic evaluation of table grapes in search of suitable cultivars for high deserts in the United States

Esmaeil Fallahi

University of Idaho, Parma Research and Extension Center, 29603. U of I Lane, Parma, ID-83660, USA.
E-mail: efallahi@uidaho.edu

Abstract

Long-term adaptability and feasibility of table grape production under the high desert conditions of southwest Idaho in the Intermountain West region of the United States were studied systematically in two phases. In the first phase, 'Alborz', 'Challenger', 'Italia', 'Emerald', 'Red Globe', 'Delight', 'Fantasy', 'Flame' and 'Fresno' (all *Vitis vinifera* L.) and NY36095, NY47616, 'Glenora', 'Reliance', 'Vanessa', 'Saturn', 'Jupiter' (hybrids of *Vitis labrusca*) had overall better berry quality and consumer preference than other tested grapes. In the second phase, 'Ralli' (also called 'Anahita' in the Intermountain West), 'Kashishi', and 'Autumn Royal' had excellent berry size and quality. 'Anahita' was harvested between Sept 1 and Sep 30. Both 'Kashishi' and 'Autumn Royal' were late-season grapes and matured between Sept 15 and Oct 15. 'Princess' was harvested between Sept 5 and Sept 30. This grape had outstanding flavour but the fruit set was low and clusters were small (268 g). 'Alborz' was harvested between Sept 1 and Sept 30, and with proper thinning, this cultivar had outstanding clusters and berries. Considering all viticultural and quality attributes, we recommend 'Alborz' as a potentially successful table grape for planting in small or large commercial scales under conditions of this study.

Key words: Cold region table grapes, cultivar evaluation, grape genotype, grape adaptability, high desert table grape. Intermountain West region

Introduction

The annual world production of grapes exceeds 67 million tons (FAOSTAT, 2009). The genus *Vitis* has over 70 species of which, *Vitis vinifera* accounts for more than 90% of the world grape production (Alleweldt and Possingham, 1988). Grape germplasm collections, including wild species, cultivars, and selections have been established in many countries as a result of active breeding programs using *V. vinifera* and/or interspecific hybrids (Reisch and Pratt, 1996; Shiraish *et al.,* 2010). Controlled crossing between native table grape cultivars are underway to create new genotypes and to improve qualitative and quantitative traits of existing germplasm (Ebadi *et al.,* 2009; Zhao *et al.,* 2009).

In the United States, various viticultural and berry sensory characteristics are well documented in California where *V. vinifera* is widely grown (Nelson, 1985; Nelson *et al.,* 1973; Weaver, 1976), while these factors are less studied in other states. The increasing costs of gas and labour, fluctuating prices of tree fruits, and the public concerns about the global warming have created challenges for traditional tree fruit growers in the recent years. These challenges have resulted in efforts to develop table grape cultivars or to modify cultural practices to produce table grapes adaptable to regions beyond California, to reduce the cost of transportation and to create a niche market (Fallahi *et al.,* 2001; Fallahi, 2006). Table grape, even at a small scale would fit perfectly in the operation of any wine grape, small fruit, and tree fruit grower in the Intermountain West region, including Washington, Idaho, Utah, Colorado, and Oregon. Table grapes in this region are harvested when most of the fresh table grapes in California are either finished or they are only available in storages. Inspite of the importance of table grape production outside of California, only limited information is available on vine and berry characteristics of cultivars in the new regions such as Idaho (Fallahi *et al.,* 2001; Fallahi, 2006), Ohio (Cahoon *et al.,*1985), Florida (Mortensen and Balerdi, 1974; Mortensen and Harris, 1988); British Columbia (British Columbia Ministry of Agriculture, Fisheries and Food,1993; Reynolds *et al.,* 1992; Margaret *et al.,* 1996); and Western Oregon (Hemphill *et al.,* 1992). Also, for locations other than California, only limited information is available on improvement of cultural practices for table grapes production (Fallahi *et al.,* 1995; Wolf and Brown, 1995)

The Pomology and Viticulture Program at the University of Idaho has been initiated during the past two decades, extensively studying the adaptability and feasibility of growing table grapes in southwest Idaho which has representative climate conditions to those of other locations in the Intermountain West region (Fallahi *et al.,* 2001; Fallahi, 2006). The main objective of the present study was to systematically evaluate adaptability of new selections and cultivars of table grapes and to improve berry quality attributes of the promising cultivars in the region.

Materials and methods

General description of experimental vineyards: The experimental vineyards were established at the University of Idaho Parma Research and Extension Center, near Parma Idaho, USA. The experimental site was located at 43.8° N latitude, 116.9° W longitude, and 673 m elevation above sea level, with an annual precipitation of about 297 mm and a sandy loam soil of pH ~ 7.3. A drip irrigation system was installed and vines were irrigated according to the ETc information provided from the Agrimet Weather Station at the University of Idaho Parma location. Vines were trained into bilateral cordon canopy system.

First phase of the evaluation of cultivars and berry quality: The cultivars for the first phase were planted in a complete randomized block design with seven replications, with two vines per location (a total of 14 vines per selection) in 1990. In spring of every year, dead and frozen vines were taken out and replaced with varieties that show satisfactory performance. Table grape cultivars in these experiments were obtained from various sources, including Plant Foundation Material Services, Davis, California, various private breeders, and grape cultivar collectors. Cuttings were rooted by a suitable technique that we developed for the cold regions. Cultivars tested during the first phase were 'Canadice', 'Challenger', 'Concord', 'Concord Seedless', 'Delight', 'Einset', 'Fantasy', 'Fiesta', 'Flame 1', 'Alborz', 'Fresno', 'Himrod', 'Interlaken', 'Mars', NY36095, NY36289, NY36661, NY47616, NY65.479.1, NY65.483.2, 'Pasargad', 'Red Globe', 'Reliance', 'Ruby', 'Vanessa', V52139, 'Saturn', 'Lake Mount', 'Venus', 'Exotic', 'Italia', 'Emerald', 'Crimson', 'Calmeria', 'Jupiter', 'Emporer', 'Rouge Deloire-4', and 'Neptune'.

Second phase of the evaluations of cultivars and berry quality: In spring of 2002, several cultivars, including 'Alborz' and 'Emerald' (from the first phase), 'Ralli' (also called 'Anahita' in the Intermountain West), 'Autumn Royal', 'Princess', 'Kashishi', 'Neptune', 'Red Globe', 'Flame' and 'Jupiter' were propagated and planted for the second phase of our cultivar section. The vine spacing was 1.8 x 2.7 m and the experimental design for this planting was a complete randomized arrangement with at least 12 replications per cultivar or selection. The ground was prepared and fumigated with *Toluene* 2 before planting.

Fruit quality attributes, including berry size, colour, berry skin characteristics, and cluster weight and shape were measured at harvest times. Vine survival after each winter was monitored, and cold tolerance of each variety was determined. Five vines of each cultivar were sprayed with gibberllic acid (GA) three times, each time at 50 ppm. The first spray was done at the beginning of fruit set (berries at about 4 mm) and the second and third GA sprays were applied at a weekly interval after the first spray.

For 'Alborz' cultivar in the second phase of the experiment, 1/3 of the tip of each cluster was removed and the number of clusters was adjusted to maximum of 20 clusters when vines were young and 28 when they were mature.

Monitoring phenological dates in Alborz grape: Since 'Alborz' was found to be the most important commercial cultivar during first phase of the study, dates for bloom, fruit set, girdling, and cluster tipping and/or removal and times for GA sprays were recorded in this cultivar over 8 years between 2000 and 2007.

Experimental designs and statistics: The experiment was arranged based on a completely randomized design with 14 individual vines per cultivar or selection in the first phase and 12 vines per cultivar in the second phase of evaluations, as described for each experiment earlier. The assumption of normal data distribution was checked by performing univariate analyses for all vine responses in the study. Analyses of variance were conducted using SAS (2007), with PROC GLM and means were separated using Fisher's Protected Least Significant Difference (LSD) at $P \leq 0.05$.

Results and discussion

First phase of table grape cultivar evaluation: Consumer fruit preference is referred to overall preference for yield, berry shape, colour, size, skin type, seediness, flavour, soluble solids concentration (SSC), crunchiness, and/or cluster size. In the first phase of this project, we found that although a majority of tested grape genotypes can be grown, 'Challenger', 'Delight', 'Fantasy', 'Flame', 'Alborz', 'Fresno', 'Glenora', NY47616, NY36095, 'Red Globe', 'Reliance', 'Vanessa', 'Saturn', 'Italia', 'Emerald', 'Jupiter' had better overall performance under the climate conditions of southwestern Idaho (Table 1). 'Challenger' produced large berries and very attractive clusters of dark-red berries that lasted on the vines until November or later. Berries in this cultivar seemed to shrivel under moderate drought conditions. 'Fresno' produced yellow berries that were crunchy and were pleasant for fresh consumption or for making raisins. 'Vanessa' produced extremely attractive red berries that were very crunchy and stayed firm on the vine for a long time. The cuttings of this grape, however, were difficult to propagate and vines were not very productive. Over the years, we found that 'Vanessa' favors "cane" punning over "spur pruning". Both 'Fresno' and 'Vanessa' are great choices for farmer's market and a "limited-scale" planting.

'Glenora' had cylindrical shaped clusters with black and tender berries with excellent flavour. 'Glenora' was cold tolerant and was one of the most favourite cultivars for farmer's market and small-scale farming. 'Delight' had small-to-medium yellow berries with large clusters that were ideal for fresh consumption or for making raisins. Due to the medium size of berries, we do not recommend 'Glenora' or 'Delight' cultivars for a large-scale planting in Idaho. NY 36095 had attractive clusters with yellow and semi-tender berries with mild "Lubrasca" flavour. NY 47616 (also called 'Sweet Shelly' in the Intermountain West region) was the earliest maturing grape with small blue colour berries that could be mixed with cereal or ice cream. Although NY 47616 may not have any major commercial value due its loose clusters and shattering, the public has shown a high interest for this grape and some growers are selling it at much higher prices than some commercial cultivars. Resemblance of berries to blue berry and the outstanding flavour and multiple uses of the berries in 'Sweet Shelly' are the major factors that consumers like this grape.

'Fantasy' produced large and flavorful seedless berries. However, this cultivar never had consistent production from year-to year. 'Exotic' berries often cracked and were not suitable for marketing. 'Italia' was productive and matured late (mid-to late September). Storability of 'Italia' was better than many other cultivars and clusters could easily be stored at 0 °C regular-atmosphere storage without any special treatment. This cultivar is seeded and did not respond well to girdling because the girdling wound did not heal for a long time, and thus would increase the chance of frost damage (data not shown).

We discovered and named 'Pasargad' in Idaho. Pasargad is a branch mutation of 'Himrod' and because of its beautiful berry colour and outstanding flavour, is named after the magnificent ancient palace and garden complex of Cyrus the Great of the Persian Achaemenid Empire (about 500 B.C.), which once had the most advanced collection of horticultural art and science and

Table 1. Berry weight, skin type, and consumer preference of various table grapes in the first phase of evaluation

Varieties	Average of berry size (g)				Berry skin type	Consumer fruit preference (10-100)[z]
	Aug. 2000	Sept. 1999	Sept. 2000	Mean		
Alborz	2.76	2.29	3.07	2.59	Tender	95
Canadice	1.87	1.03	1.84	1.66	Slip	40
Challenger	3.98	3.55	4.69	4.08	Tender	87
Concord	2.68	2.37	2.48	2.51	Slip	35
Concord (seedless)	2.78	2.27	2.40	2.48	Semi-slip	50
Delight	2.33	1.56	2.18	2.01	Tender	80
Einset	2.31	1.95	2.46	2.23	Slip	35
Emerald	-	-	4.66	4.66	Tender	95
Exotic	4.88	-	4.84	4.86	Tender	75
Fantasy	-	-	-	-	Tender	70
Fiesta	-	-	-	-	Tender	65
Flame	2.84	2.23	2.91	2.63	Tender	94
Fresno	2.09	1.95	2.61	2.16	Tender	83
Glenora	2.41	1.20	2.39	2.20	Tender	84
Himrod	2.79	2.09	2.72	2.55	Tender	75
Interlaken	1.99	1.64	1.93	1.86	Slip	40
Italia	4.10	-	-	4.10	Tender	96
Lakemont	2.23	2.09	2.64	2.32	Tender	70
Mars	2.42	1.87	2.93	2.41	Semi-slip	50
NY36095	2.30	2.11	2.65	2.30	Semi-tender	76
NY36289	-	2.30	2.85	2.59	Slip	20
NY36661	2.22	1.49	2.26	1.95	Semi-Slip	20
NY47616	1.75	1.29	1.62	1.55	Semi-slip	83
NY65.479.1	2.18	1.92	2.29	2.11	Slip	30
NY65.483.2	2.03	1.76	2.07	1.94	Slip	74
Pasargad	2.54	2.39	3.04	2.61	Tender	86
Reliance	2.76	2.24	2.69	2.54	Semi-slip	84
Romulus	2.45	1.54	-	1.99	Tender	76
Ruby	1.33	2.03	2.80	2.35	Tender	81
Saturn	2.92	2.53	3.38	2.94	Tender	96
V52139	1.58	1.70	2.09	1.76	Slip	20
Vanessa	2.41	2.03	3.01	2.35	Tender	85
LSD (P=0.05)	0.59	0.53	0.73	0.53		

10 = undesirable, progressing to 100 = outstanding; this rating is an overall fruit quality preference including berry size, colour, and peel tenderness, and seediness, assessed by over 200 people.

many fruit species including grapes. 'Pasargad' has semi-loose clusters with bright red-maroon berries without any shatter. 'Pasargad' juice is extremely attractive 'Rose' colour. The vine is very productive and relatively cold tolerant. Although 'Pasargad' may not be valuable for a large-scale planting due it's soft berries, the outstanding berry flavour and tenderness and extremely attractive colour of berries would make 'Pasargad' a highly suitable grape for small-scale or farmer's market.

'Reliance' was very productive and matured during early September every year. This cultivar can tolerate several degrees below freezing and thus recommended for areas that are prone to frost. The berries have light red colour with a "lubraska" flavour. 'Reliance' does not have a typical tender "*vinifera*" type table grape texture and flavour and thus may not have large-scale appeal for marketing, although it would be suitable for farmer's market.

'Saturn' produced small cluster with crunchy and oval shape berries and attractive maroon colour. The cluster needs direct sunlight in order to develop full colour. 'Saturn' berries tended to have a soft seeds when they were stressed or when clusters remained on the vine passed their normal maturity. This cultivar would be excellent for 'farmer's market'. Small cluster of this grape makes it a perfect snack for consumption of children.

Among the successful grapes in the first phase, 'Alborz' (a mutation of 'Flame'), 'Flame', and 'Emerald' had commercial production potential and have been planted at a large scale in the Intermountain West region since we started this study. More detail on cluster and berry maturity, quality, and management of 'Alborz' is given in the following sections.

'Emerald' produced four years after planting. This grape had extremely large clusters with large berries. This grape, however, had rather soft berries and was very sensitive to powdery mildew and sunburn. This cultivar might perform better if trained as an open canopy where there is more air movement, resulting in less incidence of powdery mildew.

Other cultivars planted in the first phase of this long-term study would not be suited for either small or large scale planting.

Second phase of table grape cultivar evaluation: In the second phase of the project, "Alborz', 'Ralli' (also called 'Anahita' in the Intermountain West) had excellent berry quality and size (Table 2). 'Autumn Royal' and 'Kashishi' had excellent berry size (7.3 g and 8.19 g per berry, respectively) and flavour. Both 'Kashishi' and 'Autumn Royal' were late-season grapes and matured between Sept 10 and Oct 15 (Table 2), and they tasted best between Oct 1 and Oct 15. 'Kashishi' is a seeded grape and could replace 'Red Globe' in the market in the Intermountain West region due to its superior flavour, and cluster and berry shape. Production in 'Autumn Royal' was low and inconsistent.

In the second phase, we performed a heavier shoot thinning in both 'Alborz' and 'Emerald' and the incidence of powdery mildew was reduced drastically. 'Alborz' grape could be harvested between Sept 1 and Oct 10. 'Alborz' berries were red to maroon and could turn deep maroon if clusters remained on the vine. Properly-managed 'Alborz' grape always had sufficient SSC after berries had complete colour. Thus, 'Alborz' can be harvested based on the market preference for the degree of redness for berry colour without any need for colour-promoting agents in the Intermountain West. These berries were seedless and extremely crunchy and remained crunchy as long as clusters stayed on the vine. There was no shattering in the berries of 'Alborz'.

Our study showed that 'Emerald' did not benefit from GA application. In fact, some times GA left undesirable marks on the 'Emerald' berries, and these marks were more evident when a 'bilateral cordon' rather than a divided canopy system was used (data not shown). The most successful 'Emerald' crop was produced when we applied fungicides every 12 to 14 days throughout the season.

Table 2. Summary of various characteristics of the table grape cultivars in the second phase of evaluation[z]

Cultivar	Seed	Berry wt (g)	Cluster wt (g)	Berry colour	Harvest date	Skin	GA need	Overall	Comments
Alborz	SL	5.07	534	Maroon Red	Sept 1-Oct.10	Tender	Yes	Excellent	
Anahita	SL/T	5.24	526	Red/maroon	Sept 1-Sept 30	Tender	Yes*	Excellent	Sensitive to spring frost
Autumn Royal	SL	7.03	703	Black	Sept 15-Oct 15	Tender	Yes*	Excellent	Mild sunburn
Princess	SL	6.55	268	Green	Sept 5-Sept 30	Tender	No	Excellent	Poor fruit set
Kashishi	SD	8.19	522	Maroon	Sept 15-Oct 15	Tender	Yes*	Excellent	Very pleasant taste
Emerald	SL	4.60	837	Green	Sept 10-Oct 15	Tender	No	Medium	High sunburn and powdery mildew
Neptune	SL	4.11	210	Green	Sept 5-Oct 5	Slip	Yes*	Medium	Nice berries, Muscat flavour
Red Globe	SD	7.10	530	Red	Sept 20-Oct 20	Tender	Yes*	Good	Late season
Flame	SL	5.06	529	Maroon/Red	Sept 1-Oct10	Tender	Yes	Excellent	Needs crop management
Jupiter	SL/T	4.10	204	Black	Sep 1-Oct 15	Tender	Yes*	Excellent	High yield, cold tolerant, fresh & raisins
LSD (P=0.05)		1.0	102						

[z]Abbreviations: SL=Seedless; SD=Seeded; SL/T= Seedless/Trace; Each cultivar was harvested based on its berry maturity. GA-gibberllic acid, cultivars indicated by * could perform better with GA but they also had reasonable berry size without GA.

Table 3. Average dates of dormant sprays, full bloom, cluster thinning, cluster shortening, and gibberellic acid (GA) applications in 'Alborz' grapes at the University of Idaho Parma Research and Extension Center in 2000-07

Year	Dormant spay	Full bloom	Actual shoot and cluster adj.[z]	Girdling (If done)	First GA	Second GA	Third GA
2000	April 3	June 10	June 21	June 21	June 20	June 27	July 3
2001	April 3	June 10	June 22	June 22	June 21	June 30	July 7
2002	April 7	June 14	June 25	June 25	June 24	July 2	July 9
2003	April 9	June 14	June 25	June 25	June 24	July 1	July 9
2004	April 10	June 9	June 23	June 23	June 23	June 30	July 8
2005	April 5	June 17	July 1	July 1	July 1	July 8	July 14
2006	April 13	June 9	June 16	June 16	June 18	June 28	July 5
2007	April 6	June 8	June 12	June 16	June 15	June 22	June 28

[z]Actual shoot & cluster adj.(adjustment) = the actual date that we removed the excess shoots and clusters and shortened 1/3 to 1/2 of the remaining ones. Note: in the second phase of evaluation, we found that we could have removed the excess shoots a few days earlier for a smoother operation and better results, because shoots were shorter. We also found that the follow up GA could have been applied with 4-5 days of the previous one.

'Princess' was harvested between Sept 5 and Sept 30 (Table 2). This grape had outstanding flavour but the fruit set was low and clusters were rather small (268 g). 'Princess' grape showed marginal leaf chlorosis that started at fruit set and continued throughout the season. The symptoms were similar to potassium (K) deficiency. In two seasons, we applied high levels of potassium (about 30 g K as KCl/vine) and this application reduced the poor fruit set problem to some extent (data not shown). Based on this study, 'Princess' is not recommended until the fruit set problem is resolved. We also found that 'Princess' table grape does not favour GA sprays.

We continued our evaluation with 'Jupiter' in the second phase of evaluation. This cultivar appeared to be cold tolerant and suffered almost no frost damage during many years of our evaluation. Berry size was improved drastically with some cluster removal and by using a divided canopy rather than a bilateral cordon (data not shown). 'Neptune' clusters size and berry weight was comparable with those of 'Jupiter'. However, berry flavour in 'Jupiter' was by far superior to that of 'Neptune'. Although 'Neptune' produced attractive small clusters with virtually no shatter, the berries had a strong "foxy" after taste and were unpleasant to most consumers.

Crop adjustment and phenological dates in 'Alborz' grape: Since 'Alborz' had desirable berry quality attributes in our first phase of evaluation, it was used in the second phase. The number of clusters in 'Alborz' was reduced at fruit set to 20 clusters (in young vine) and to 28 vines (in the mature vines) in the second phase of evaluation. In the remaining clusters, about one third of the tip of each cluster was removed at fruit set and the vines were sprayed with three GA applications as described earlier. These clusters had an average weight of 534 g with an average berry weight of 5.07 g (Table 2) and berries were large enough to be put 'Alborz' in the a high berry size category for "flame type" grapes in the commercial grape market.

In a different study, various cluster management practices were performed on 'Alborz'. In that study, Alborz vines that received cluster shortening and cluster removal plus girdling had significantly larger berries than control vines (data not shown). From this study, we conclude that both cluster removal and cluster shortening are essential for obtaining large berries.

Dates for the late-dormant spray (when buds just started to move) varied between April 3 and April 13 during the 2000 and 2007 period (Table 3). During this period, dates of full bloom were between June 9 and June 17 and dates for shoot thinning, cluster thinning and tip shortening were between June 12 and July 1 (Table 3). During these dates, shoots were about 50 to 65 cm long. Since 2007, we have been thinning shoots at earlier dates than before, when shoots were about 35 to 45 cm long (data not shown). It is easier to thin shoots when they are shorter and adjust the clusters later, when fruit set has been taken place. Dates for the first GA applications were usually close to the shoot and cluster thinning dates between 2000 and 2007 (Table 3).

Application of GA at 50 ppm was the optimum rate for 'Alborz' table grape. Although application of GA at 60 ppm resulted in large berries as compared to control, berry colour was delayed or stayed green in some years (data not shown).

This study revealed that 'Alborz' can be grown in the Intermountain

West region at a large scale for both domestic and export markets. Shoot thinning and removal of excess clusters and tip of the remaining clusters is an essential cultural practice in some cultivars such as 'Alborz'. 'Emerald', 'Ralli' and 'Autumn Royal' can also be grown commercially in the region. However, each of these varieties has its own challenges and needs for special cluster and shoot thinning.

Based on this study, several cultivars, including 'Jupiter', "Glenora', 'Pasargad', 'Vanessa', 'Sweet Shelly', and 'Fresno' can be grown on a small-scale for farmer's market.

Overall, the Intermountain west region of the USA can be an outstanding site for production of table grapes for niche market but a number of climatic and cultural manipulations should be practiced to produce optimum quality. This study underscores the needs for further research projects on evaluating newer cultivars and cultural practices and understanding the environmental reactions in the region.

References

Alleweldt, G., J.V. Possingham, 1988. Progress in grapevine breeding. *Theor. Appl. Genet*., 75: 669-673.

British Columbia Ministry of Agriculture, Fisheries and Food. 1993. *Grape Production Guide*. Extension Systems Branch, Victoria, BC.

Cahoon, G.A., L.G. Anderson, G.R. Passewitz, D.E. Hahn, A.E. Oden and R. Gruber, 1985. Fresh market grapes from Ohio vineyards. *Ohio Report May-June,* 37-40.

Ebadi, A., J. Erfani Moghadam and R. Fatahi, 2009. Evaluation of 22 populations achieved from controlled crossing between some seeded × seedless grapevine cultivars. *Scientia Horticulturae,* 119: 371-376.

Fallahi, E., H. Heydari and M. Kilby, 1995. Maturity, quality, and production of 'Thompson Seedless' grape as affected by frequency of gibberellic acid with and without naphthaleneacetic acid. *J. Small Fruit and Viticulture,* 3: 49-61.

Fallahi, E., B. Fallahi and I.J. Chun, 2001. Adaptation, maturity, and fruit quality of table grapes in the Intermountain West region of the U.S.A. *J. Small Fruit,* 1: 29-42.

Fallahi, E. 2006. Table grape variety evaluation and improving berry quality, size and yield, under desert conditions of the Pacific Northwest. *Proceeding of the Northwest Center for Small Fruit Research 14th Annual Conference,* 72-73.

FAOSTAT, 2009. *Production yearbook*. Food and Agriculture Organization of the United Nations*, Rome. http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor*

Hemphill, D.D., W.A. Sheets and L.W. Martin, 1992. Seedless table grapes for Willamette Valley. *Oregon State University Ag. Expt. St. Corvallis, Oregon, Special Report* 893.

Margaret, A., A. Cliff, M.C. Marjorie, C. Dever and A.G. Reynolds, 1996. Descriptive profiling of new and commercial British Columbia table grape cultivars. *Amer. J. Enol. Vitic.,* 47: 31-38.

Mortensen, J.A. and C.F. Balerdi, 1974. Muscadine grapes for Florida: yields and other characteristics of 48 cultivars. *Proc. Fla. State Hort. Soc.,* 86: 338-341.

Mortensen, J.A. and J.W. Harris, 1988. Muscadine and bunch grape fresh fruit taste panels during 21 years with 101 cultivars. *Proc. Fla. State Hort. Soc.,* 101: 229-232.

Nelson, K.E. 1985. Harvesting and handling California table grapes for market. *Agric. Expt. Sta., Univ. of California Bull.,* #1913.

Nelson, K.E., J.W. Allen and H.G. Schultz, 1973. Effect of grape maturity, sample, order and sex of the taster on the flavour response of supermarket consumers. *Amer. J. Enol. Vitic.,* 23: 86-95.

Reisch, B.I. and C. Pratt, 1996. Grapes. In*: Fruit breeding,* Volume I: *Vine and Small Fruits,* J. Janick and J.N. Moore (eds.). John Wiley & Sons, Inc. p. 297–369.

Reynolds, A.G., D.A. Wardle, C. Zurowski and N.E. Looney, 1992. Phenylureas CPPU and thidiazuron affect yield components, fruit composition, and storage potential of four seedless grape selections. *J. Amer. Soc. Hort. Sci.,* 117: 85-89.

SAS Institute, 2007. *SAS/STAT1 User's Guide*. Version 9.2, SAS Institute, Cary, NC.

Shiraish, M., H. Fujishima and H. Chijiwa, 2010. Evaluation of table grape genetic resources for sugar, organic acid and amino acid composition of berries. *Euphytica*, 174: 1-13.

Weaver, R.J. 1976. *Grape Growing.* Wiley-Interscience Publication, New York, London, Sydney, Toronto.

Wolf, D. and G.R. Brown, 1995. Influence over a ten-year period of training system on yield and fruitfulness of table grape cultivars. *Fruit Var. J.,* 49: 79-81.

Zhao, S.J., X.Z. Zhang and Z.J. Guo, 2009. Characteristics of new triploid seedless table grape cultivar 'Champion Seedless' released in China, *Acta Horticulturae,* 827: 451-455.

Received: June, 2011; Revised: August, 2011; Accepted: October, 2011