trees, although there were minor and inconsistent differences. However, (8) studied the size, shape and total weights of nuts in *J. regia* L. and found that the populations of different ages showed the species to be very polymorphic. He observed a clear tendency for the number of large nuts, weight and thickness of shell to diminish with age.

In conclusion, these studies show that there is extreme variation in almost all nut characters. These characters are least affected with age of the trees. Thirty promising seedlings having desirable attributes have been selected for further multiplication and planting in the collection block of the Department of Fruit Breeding & Genetic Resources.

References

1. Chauhan, J. B. and S. D. Sharma. 1979. Phenotypic variability in walnut of Kinnaur district of H. P. Indian Jour. Agric. Sci. 49(6):420-423.
2. Donno, G., E. Ferrara and A. Reina. 1974-75. Studies on some fruit characters in Walnut (*J. regia* L). Annali-della Facolta-di-AGraria-Universita-di-Bau 27:355-372.
3. FAO. 1994. FAO Production Yearbook, Rome, Italy.
4. Hanche, P. E., V. Beres and H. I. Forde. 1972. Estimates of quantitative genetic properties of walnut and their implication for cultivar improvement. J. Amer. Soc. Hort. Sci. 97:279-285.
5. Lal, H. and R. D. Singh. 1978. Some promising walnut strains in Chakarata hills of U.P. Prog. Hort. 10(1):61-66.
6. McGranahan, G. and C. Leslie. 1990. Walnuts (Juglans) In: Genetic resources of temperate fruits and nut crops. Acta Horticulture 290(2):907-951.
7. Nauriyal, J. P., K. L. Chadha and H. Kumar. 1970. Some promising walnut trees in the Kullu Valley. Jr. Res. PAU 6(3):852-857.
8. Nenyukhin, V. N. 1972. Population variability in walnut seeds. Rastitel'n-resnrsy 8(1):60-68.
9. Pandey, D. and M. M. Sinha. 1984. Some promising selections of walnut from Jaunsar Bhabhar area of Garhwal hill. Morphological studies. Prog. Hort. 16(3-4):183-187.
10. Panse, V. G. and P. V. Shukhatme. 1957. Statistical Methods for Agricultural Workers. ICAR New Delhi.
11. Upov. 1988. General information—International Union for the protection of new varieties of plants ITG/125/1 Project Geneva, Switzerland.
12. Paunovic, S. A. 1990. The walnut cultivars selected from indigenous population of *Judlans regia* L. in SR Serbia, SFR Yugoslavia. Acta Horticulture 284::135-141.
13. Sharma, S. D. and J. S. Chauhan. 1980. A note on variability in nut characters of walnut seedlings. Punjab Hort. Jour. 20(1&2):78-79.
14. Thakur, D. 1993. Genetic variability in bearing seedling walnuts (*J. regia* L.) in Kullu Valley. Solan U.H.F. Thesis (M.Sc.) 1993.

Fruit Varieties Journal 52(1):23-27 1998

Performance of Nine European Plum Cultivars on Two Rootstocks in East-Central Ontario

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Abstract

Nine plum (*Prunus domestica* L.) cultivars were assessed over a 10-year period for growth, yield, fruit weight, bloom, petal fall and fruit harvest dates and cold temperature injury. The highest yields were obtained from 'Veeblue' and 'Vision'. 'Veeblue' had a higher yield efficiency and a lower cold temperature injury rating compared to 'Vision'. Cropping inconsistency encountered over the period of this trial would make commercial plum production in the east-central region of Ontario marginal. Cold temperatures during the winter of 1993-94 resulted in considerable injury to the trees. With the exception of 'Veeblue', the other cultivars tested from the breeding program at the Horticultural Research Institute of Ontario, Vineland Station, Ontario, suffered more cold temperature injury than did 'Italian' and 'Stanley'. Trees grown on 'Brompton' (*P. domestica* L.) rootstock were about 20% smaller compared to trees on 'Myrobalan B' (*P. cerasifera* Ehrh.).

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Introduction

In Ontario, 96% of the European plum trees grown are in the Niagara or southwestern regions of the province (1). There is potential for increased plum production in other parts of the province to meet fresh market demands.

The plum breeding program at the Horticultural Research Institute of Ontario (HRIO), Vineland Station, Ontario, has resulted in the release of 'Valor,' 'Verity' and 'Vision' (2), 'Veeblue' (6) and 'Victory' (9) which are September ripening cultivars. In 1963, the emphasis of the breeding program shifted to breeding for cultivars that ripen in August (8). 'Voyageur' (7) was the first August ripening plum, named in 1987, and several other advanced selections were released for testing. V70031 and V66071 are recommended for trial planting in Ontario as August ripening European plum types (3). V68011 is recommended as a pollinator for V70031 and V66071 (3).

The objective of this trial was to compare the performance of August ripening selections to standard plum cultivars using 'Myrobalan B' and 'Brompton' rootstocks. A secondary objective was to determine the relative cold hardiness of the plum cultivars and selections and to determine the reliability of production of plums in the east-central growing region of Ontario.

Materials and Methods

The experimental planting consisted of nine European plum cultivars and selections ('Italian,' 'Stanley,' 'Valor,' 'Veeblue,' 'Victory,' 'Vision,' V66071 ('Early Rivers' x 'Stanley'), V68011 ('Early Rivers' x 'Ruth Grestetter') and V70031 ('Valor' x 'California Blue')) on each of 'Brompton' and 'Myrobalan B' rootstocks. The trees were planted in a Berrien sandy loam soil on 9 May 1984 at the Smithfield Research Farm, Trenton, Ontario. The experimental site was fumigated with methyl isothiocyanate + 1,3-dichloropropene on 11 October 1983. The orchard was planted as a split plot design with cultivar as the main plot, replicated four times, and subplots consisting of two trees of each cultivar on each rootstock. Trees were spaced at 5.0 x 5.5 m.

Trees were trained to a modified central leader system and limb spreading was done in the spring of the second to the sixth years to encourage wide crotch angles. Vegetation control in the tree rows was accomplished with herbicides. Alleys were grass and mowed as required.

Date of first bloom (first blossom open), full bloom (when 80% of the blossoms were open) and 75% petal fall was recorded annually. At harvest, the crop from each tree was weighed and a random sample of 300 fruit per cultivar was weighed to determine mean fruit weight. Trunk circumference (1984 to 1989) or trunk diameter (1990 to 1993) measurements at 30 cm above the ground were taken annually in the autumn and expressed as TCA.

On 12 July 1994 a visual assessment of low temperature injury for each tree was made using the International Board for Plant Genetic Resources (IBPGR) low temperature injury rating scale (12).

1 = extremely hardy (no visible dieback);

3 = hardy (slight dieback, end of branch flagging);

5 = intermediate (10 to 25% dieback);

7 = tender (25 to 50% dieback)

9 = extremely tender (> 50% dieback).

The mean low temperature injury rating for each cultivar on each rootstock was determined.

Data for annual and cumulative yield, yield efficiency, trunk cross-sectional area (TCA) and cold temperature injury were analyzed using an analyses of variance (ANOVA) for split plot design and Duncan's multiple range test (5). TCA data was analyzed for each rootstock separately since there was a significant cultivar x rootstock effect in the original analysis.

Results and Discussion

Cultivar effects. Since the cultivar X rootstock effect was significant, the TCA data is shown separately for each rootstock (Table 1). By the autumn of 1993, TCA was largest for 'Vision' on both root-

Table 1. Trunk cross sectional area for nine European plum cultivars on Myrobalan B and Brompton rootstocks from 1984 to 1993 at the Smithfield Research Farm, Trenton, Ontario.

Rootstock and cultivar	Truck cross-sectional area (cm^2)									
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Myrobalan B										
V68011	4.1b[z]	10.9b	22.5b	38.3bcd	61.1bcd	72.4bc	96.2cd	117.2bc	138.5bc	158.6bc
V70031	4.7ab	11.3b	23.1b	34.0d	54.8d	70.4bc	108.5bcd	124.6bc	157.0bc	178.5bc
V66071	5.5ab	14.6ab	28.8ab	46.5abc	75.0ab	89.2ab	117.6bcd	140.1bc	154.1bc	174.0bc
Veeblue	4.6ab	13.4ab	25.4b	40.8bcd	59.1cd	75.9bc	106.9bcd	127.4bc	151.7bc	174.3bc
Victory	4.3ab	13.5ab	29.2ab	47.4ab	74.0abc	88.8ab	124.1ab	141.0bc	176.7ab	204.7ab
Stanley	4.5ab	10.9b	21.6b	35.8cd	55.4d	68.1c	94.2d	109.2c	131.0c	149.5c
Valor	4.3ab	10.9b	24.2b	35.6cd	54.5d	66.7c	97.7cd	112.0c	141.0bc	155.5bc
Italian	4.4ab	11.6b	22.3b	39.4bcd	58.6cd	83.3abc	122.4abc	148.6ab	165.4abc	188.5bc
Vision	5.5a	17.1a	33.0a	51.9a	79.2a	98.2a	146.6a	175.6a	198.1a	236.2a
Brompton										
V68011	4.1abc	10.2abc	19.4b	30.5c	46.9c	58.5b	78.4b	95.2b	118.0	142.8ab
V70031	3.9abc	9.4bc	19.7b	31.7bc	48.9abc	62.0b	88.8ab	104.4b	128.7	144.6ab
V66071	5.0a	13.7a	25.7ab	38.2abc	60.8ab	69.3ab	91.5ab	105.5b	121.5	134.0b
Veeblue	4.5ab	13.4a	25.4ab	39.7abc	57.1abc	71.8ab	96.9ab	112.6ab	132.9	146.1ab
Victory	4.2abc	12.7abc	27.7a	41.6a	61.4ab	69.9ab	94.1ab	108.3b	136.6	147.7ab
Stanley	4.5ab	11.1abc	22.7ab	35.0abc	54.7abc	65.7ab	97.9ab	108.2b	126.4	143.1ab
Valor	3.5bc	9.8abc	21.8ab	35.8abc	51.4abc	62.3b	92.1ab	105.2b	122.6	143.7ab
Italian	3.1c	9.1c	19.1b	32.6abc	47.7bc	66.4ab	92.9ab	117.3ab	132.0	142.3ab
Vision	4.3abc	13.1ab	25.7ab	40.5ab	62.2a	77.6a	111.3a	130.7a	144.1	165.3a

[z]Means followed by the same letter within each column for cultivar (within each rootstock) are not significantly different using Duncan's Multiple range test (P = 0.05). Absence of letters indicates no significant difference.

stocks. On 'Myrobalan B' rootstock, all cultivars except 'Victory' had a smaller TCA compared to 'Vision' (P = 0.05). 'Stanley' had the smallest TCA and was significantly smaller than 'Victory,' and 'Vision' (P = 0.05). On 'Brompton' rootstock, 'Vision' differed in tree size only from V66071 (P = 0.05). Other cultivars were intermediate in TCA.

'Veeblue' and 'Vision' were the highest yielding cultivars in this trial (Table 2). 'Veeblue' also had the highest yield efficiency. When 'Veeblue' was released in 1984 by Tehrani (6), he reported 'Veeblue' as being more productive than other cultivars tested.

The August ripening selections V70031 and V66071 had a lower cumulative yield than 'Veeblue' or 'Vision' (P = 0.05) but yield was comparable to the other named cultivars in this trial. The cumulative yield of the August ripening selections, V70031 and V66071 were not significantly different (P = 0.05) from V68011. However, V68011 and V70031 had a lower yield efficiency compared to V66071 (P = 0.05).

Yield data for 1991 was only available for V68011 (27.9kg/tree), V70031 (44.3 kg/tree) and V66071 (36.1 kg/tree). Although not recorded, the other cultivars also had large yields in 1991. Consistency of cropping is an important factor for commercial production. However, cropping was inconsistent in this trial. Large crops were obtained in 1989 and 1991 with relatively light crops in the other crop years. Spring frost which killed many flower buds accounted for the light crop in 1988. The 1990 crop was light because of below normal temperatures in November and December 1989, a light bloom, poor pollinating conditions and frost in the spring of 1990. After the large crop of 1991, return bloom in the spring of 1992 was generally light, likely due to a biennial bearing influence. However, bloom in the spring of 1993 was also gen-

Table 2. Total and cumulative yield and cumulative yield efficiency from 1987 to 1993 for nine European plum cultivars at the Smithfield Research Farm, Trenton, Ontario.

Cultivar or Rootstock	Total yield (kg/tree)						Cumulative 1987-93[x]	Cumulative yield effic. (kg/cm^2) 1987-93[x]
	1987	1988	1989	1990	1992	1993		
Cultivar								
V68011	0.8c[y]	0.3b	15.4d	1.2d	13.3c	4.9de	35.9c	0.24e
V70031	0.7c	tr[z]b	36.5bc	0.9d	0.3d	8.8cde	47.2bc	0.28de
V66071	4.3ab	1.3a	38.7bc	2.2cd	13.7c	2.3e	61.4bc	0.41bc
Veeblue	1.5bc	1.9a	54.8a	5.8ab	22.2bc	19.7ab	105.8a	0.66a
Victory	3.2bc	0.1b	45.7ab	0.9d	0.5d	16.6abc	66.8b	0.37cd
Stanley	1.1c	0.4b	36.0bc	6.8a	2.8d	22.9a	71.0b	0.49b
Valor	4.3ab	0.1b	30.3c	4.0bc	1.2d	9.4cde	49.2bc	0.33cde
Italian	1.0c	1.4a	12.5d	1.9cd	29.8ab	11.8bcd	58.4bc	0.36cd
Vision	6.9a	0.2b	50.2ab	3.6c	35.7a	4.0de	100.9a	0.48d
Rootstock								
Myrobalan B	3.3a	0.7a	39.1a	2.7b	12.9a	12.4a	71.1a	0.39a
Brompton	1.9b	0.5b	31.0b	3.3a	14.0a	9.9b	59.2b	0.40a

[x]Not including 1991.
[y]Means followed by the same letter within each column for cultivar or rootstock are not significantly different using Duncan's multiple range test (P = 0.05).
[z]tr = less than 0.05.

erally light and no satisfactory explanation for this was established.

In the trial, 'Victory' had the highest mean fruit weight among the nine cultivars tested (Table 3). Tehrani and Lay (9) also reported 'Victory' as having the highest mean fruit weight among a group of seven cultivars tested at Vineland, Ontario. In the present trial, V70031 (51.8 g) had a similar fruit weight to 'Valor' (50.0 g). V68011 and V66071 had a fruit weight of 32.3 g and 33.7 g, respectively, which was between 'Italian' (28.8 g) and 'Stanley' (36.2 g) in weight. 'Veeblue' which was the highest yielding cultivar in this trial had a mean fruit weight of 39.4 g, just slightly larger than 'Stanley.'

Table 3. Mean fruit weight of nine European plum cultivars from 1987 to 1993 at the Smithfield Research Farm, Trenton, Ontario.

Cultivar	Fruit weight (g/fruit)
V68011	32.3
V70031	51.8
V66071	33.7
Veeblue	39.4
Victory	64.0
Stanley	36.2
Valor	50.0
Italian	28.8
Vision	46.0

Later blooming cultivars may have an advantage over early blooming cultivars by avoiding spring frosts. A maximum of 4 days difference occurred between the earliest (V68011) and latest ('Italian') blooming cultivars in this trial (Table 4) but there was no overall advantage in yield with 'Italian' compared to V68011 (Table 2). In 1988 when spring frost was a factor, the total yield was less than 2 kg per tree for all cultivars. Also in 1990 when spring frost occurred, there was no difference in yield between V68011 and 'Italian,' the earliest and latest blooming cultivars.

A minimum temperature of-32°C on 23 December 1993 and on 16 January 1994 was recorded at the Smithfield Research Farm (11). During the spring of 1994, low temperature injury symptoms ranged from slight dieback of the terminal branches (rating of 3) to complete tree death (rating of 9). 'Stanley' and 'Italian' were the hardiest cultivars with mean injury ratings of 3.4 and 3.6, respectively (Table 5). 'Veeblue' and 'Valor' were intermediate in hardiness with ratings of 4.3 and 5.5, respectively. V70031 (rating of 6.8) and

Table 4. Mean bloom, petal fall and harvest date for nine European plum cultivars at the Smithfield Research Farm, Trenton, Ontario

Cultivar	First bloom[y]	Full bloom[y]	75% petal fall[y]	Harvest date[z]
V68011	May 10	May 13	May 17	Aug. 11
V70031	May 12	May 15	May 21	Aug. 20
V66071	May 12	May 14	May 20	Aug. 20
Veeblue	May 12	May 14	May 21	Sept. 5
Victory	May 12	May 15	May 20	Sept. 17
Stanley	May 13	May 16	May 22	Sept. 18
Valor	May 12	May 15	May 22	Sept. 20
Italian	May 14	May 17	May 22	Sept. 20
Vision	May 12	May 15	May 22	Sept. 22

[y]From 1989 to 1993, inclusive.
[z]From 1987 to 1993, inclusive.

'Vision' (7.7) were considered tender and V66071 (8.3), 'Victory' (8.5) and V68011 (9.0) were extremely tender with over 50% dieback. No crop was produced in 1994 due to the cold injury.

Rootstock effects. The TCA of trees on 'Brompton' rootstock was approximately 20% smaller compared to trees on 'Myrobalan B' rootstock in the autumn of 1993. Cumulative yield was higher for trees on 'Myrobalan B' rootstock compared to trees on 'Brompton' but no difference in yield efficiency occurred (Table 2). The results for tree size are similar to those reported by Tehrani and Leuty (10) in which six cultivars on 'Brompton' rootstock were 24% smaller than on 'Myrobalan B' rootstock. However, they also reported no difference in cumulative yield between rootstocks, so trees on 'Myrobalan B' rootstock had a lower yield efficiency than 'Brompton.'

Table 5. Mean low temperature injury rating for nine European plum cultivars at the Smithfield Research Farm, Trenton, Ontario in 1994.

Cultivar	Injury rating[y]
V68011	9.0a[z]
Victory	8.5ab
V66071	8.3ab
Vision	7.7ab
V70031	6.8bc
Valor	5.5cd
Veeblue	4.3de
Italian	3.6e
Stanley	3.4e
Rootstock	
Myrobalan B	6.5a
Brompton	5.9b

[y]Rating scale:
1 = extremely hardy (no visible dieback)
3 = hardy (slight dieback, end of branch flagging)
5 = intermediate (10-25% dieback)
7 = tender (25-50% dieback)
9 = extremely tender (>50% dieback)
[z]Means followed by the same letter within each column for cultivar or rootstock are not significantly different using Duncan's multiple range test (P = 0.05).

The mean low temperature injury rating was lower for trees on 'Brompton' rootstock compared to 'Myrobalan B,' however, this difference was small when compared to the cultivar effect (Table 5).

Summary

Due to a combination of factors including spring frost injury to flower buds, cold temperature injury to the trees and biennial bearing, commercial plum production in the east-central region of Ontario was inconsistent. "Good crops" were obtained in only two of the seven years tested (1989 and 1991). 'Veeblue,' which was one of the top performers in this trial due to high yield and low cold injury rating, also performed well in southern Quebec (4). The cultivars 'Stanley' and 'Italian,' while quite cold tolerant, have a smaller fruit size than 'Victory,' 'Valor' and 'Vision' which have similar ripening dates. The 'Brompton' rootstock provided about a 20% reduction in tree size compared to 'Myrobalan B' and may slightly reduce cold temperature injury to the scion cultivar.

The breeding program at the HRIO has provided a selection of cultivars which ripen in August and September with good fruit size and yield. Except for 'Veeblue' winter hardiness is less than that of 'Stanley' and 'Italian.'

Literature Cited

1. Bany, P. 1991. 1990 Tree Fruit Census Tender Fruits. Ont. Min. Agr. & Food. p. 40.
2. Bradt, O. A., C. L. Ricketson, G. Tehrani, and E. A. Kerr. 1968. New fruit cultivars from Ontario, Canada. Fruit Var. Hort. Dig. 22: 73-75.
3. Dale, A., D. C. Elfving, K. H. Fisher, N. W. Miles, G. Tehrani, and K. R. Wilson. 1992. Fruit Cultivars. Ont. Min. Agr. & Food Publ. 430.
4. Granger, R. L., A. Freve, J.-Y. Fournier, M. Meheriuk, S. Khanizadeh and G. Tehrani. 1992. Performance of several plums on the lower St. Lawrence region of Quebec. Fruit. Var. J. 46:183-186.
5. SAS Institute Inc. 1985. SAS user's guide: statistics, Version 5 (ed.). SAS Institute Inc., Cary, N.C.
6. Tehrani, G. 1984. 'Veeblue' plum. HortScience 19:591.
7. Tehrani, G. 1987. 'Voyageur' plum. HortScience 22: 684-685.
8. Tehrani, G. 1991. Seventy-five years of plum breeding and pollen compatibility studies in Ontario. Acta Horticulturae 283:95-103.
9. Tehrani, G. and W. Lay. 1992. 'Victory' plum. HortScience 27:1232-1233.
10. Tehrani, G. and S. J. Leuty. 1987. Influence of rootstock and pruning on productivity, growth, and fruit size of European plum cultivars. J. Amer. Soc. Hort. Sci. 112:743-747.
11. Warner, J. and C. Nickerson. 1996. Winter *injury* to apple trees, 1993-1994. Fruit Var. J. 50:114-118.
12. Watkins, R. and R. A. Smith. 1982. Descriptor list for apple *(Malus)*. International Board for Plant Genetic Resources, Commission of European Communities: Committee on Disease Resistance Breeding and Use of Genebanks. IBPGR Secretariat, Rome, Italy.

Fruit Varieties Journal 52(1):28-32 1998

Shank Tissue Proliferations in Apple Rootstocks: Effects on Tree Growth and Correlation with Site Factors

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Abstract

A factorial planting of three scion varieties ('Gala,' 'Fuji,' and 'Braeburn') on each of four rootstocks (Mark, M.26, M.7a, and MM.111) was established at two locations in Maryland in 1990. In 1993, trees were scored for trunk circumference (TC), extension growth, leaf color, burrknots (BK) and root mass proliferations (RMP) both above and below ground, and presence of pests on the shanks. Mark was the only rootstock with RMP; 75% of the trees examined had these tissue proliferations. The % of TC composed of RMP below ground was 2-3X higher in Mark grafted with 'Fuji' than was observed with other scion varieties. Across rootstocks, % TC composed of BK below ground was significantly affected by location. In each rootstock, regressions between growth parameters and % of TC with BK or RMP were almost all negative and many had significant correlations. In Mark, % of TC with RMP below ground (but not above) was significantly correlated with reduced TC at 25 cm. The occurrence of RMP was much greater below ground than above. Orchard surveys of trees on Mark were also conducted at several commercial sites in MD and NY. The percentage of trees showing RMP ranged from 0 to 90%. There was a significant reduction in TC at 25 cm with increasing levels of RMP. The percentage of trees with RMP and mean % of TC with RMP significantly correlated with percentage of trees having visible woolly apple aphids or their distinctive galls.

Introduction

Proliferation of several tissue types on the shanks of apple rootstocks have been anecdotally associated with poor tree performance. Burrknots, areas of concentrated root initials, develop on many root-

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Acknowledgment: This work was supported in part through funding from the Maryland Horticultural Society and the International Dwarf Fruit Tree Association.