Journal American Pomological Society 57(2):70-75 2003

Fruit Yield and Characteristics of Three Cultivars of Mirabelle Plum (*Prunus insititia* var. *syriaca*) in Northwest Spain.

C. SALINERO[1], O. AGUIN[1], AND M.J. SAINZ[2]

Abstract

Fruit yield and fruit characteristics of three cultivars of mirabelle plum (*Prunus insititia* var. *syriaca*) were evaluated from 1990-1997 in northwest Spain. 'Rosal' is the local non-improved cultivar, highly susceptible to leaf fungal diseases; 'Nancy 1510' and 'Nancy 1725' are improved virus-free clones developed by the Institut National de Recherche Agronomique (INRA, Bordeaux, France) which had not previously been cultivated in Spain. 'Nancy 1510' gave the best yield (mean annual production 31 kg per plant, versus 27 kg for 'Nancy 1725' and 6 kg for 'Rosal'), which increased steadily with age. 'Nancy' fruits were on average larger (mean weight about 9 g, versus about 7.7 g for 'Rosal' fruits). These differences may be of genetic origin, although they could also be attributable to the impact of *Stereum purpureum* on 'Rosal' plants. Although affected by this fungal pathogen, 'Nancy 1510' and 'Nancy 1725' adapted well to the climate of the study area.

Introduction

The mirabelle plum grows naturally in southern Europe and the southern Caucasus. Originally named *Prunus insititia* by Linnaeus (1), it is now designated *Prunus insititia* var. *syriaca* (Borkh) Koehne (6). The fruit is a rounded drupe, yellow when ripe, with some cultivars showing small reddish marks. The stone is a laterally compressed, elliptical freestone, occupying 80% of the cavity (7). The flesh is yellow and firm, with a sweet juicy flavor.

Mirabelle plums are cultivated in Belgium, Germany, Italy, Greece and France, the latter country being the most important producer, with an annual crop that may now exceed 30,000 tons (3). In Spain, mirabelle plums are grown only in the district of Rosal, in southern Pontevedra Province in northwest Spain (41° 56' 24" N, 8° 49' 48" W).

The mirabelle plum does not have strict edaphic requirements, but grows best on deep, well-drained, cool, slightly alkaline, fertile soils. It is resistant to cold winters but sensitive to frost, heavy rain and strong winds, particularly during flowering and fruit ripening (4,9). The climate of southern Pontevedra Province is Maritime Mediterranean according to the classification of Papadakis (2), and the temperature regime is well suited to horticulture (2). Mirabelle plums grown in this region are derived from stock imported in the 1930s from the Black Forest region of Germany; culture conditions are conventional and not subject to any rigid control (9). The cultivar currently grown is known as 'Mirabel Rosal' (hereinafter 'Rosal'). Annual production is difficult to assess, since cultivation is largely in small-scale family-owned units. One estimate suggests a figure of about 15,000 kg, almost all of which is bought by a local canning plant that processes mirabelle plums in syrup, largely for the national market (9), as also happens in the other European producing countries. However, consumption of fresh fruit of mirabelle plums has increased noticeably.

In the 'Rosal' district, mirabelle trees flower from mid-April to mid-May, as in the French region of Lorraine, but about 15 days later than in Bordeaux (5). In this region, fruits ripen gradually on the tree between about 15 July and 15 August (9). Mirabelle fruit production in northwest Spain is hindered by the susceptibility of

[1]Estación Fitopatológica 'Do Areeiro', Subida a la Robleda s/n, E-36153 Pontevedra, Spain.
[2]Departamento de Producción Vegetal, Universidad de Santiago de Compostela, E-27002 Lugo, Spain.

the plant to leaf diseases such as silver leaf (caused by *Stereum purpureum* (Pers.) Fr) and shot hole disease (caused by *Coryneum beijerinckii* Ondemans). In a survey made during three consecutive years (1984-86), all 'Rosal' trees were affected by one or both of these fungi (9). Importation from other countries, such as France, of new cultivars that have desirable characteristics such as yield, fruit size, ripening period, or resistance to handling, could enhance mirabelle production and tolerance to fungal diseases.

In the present study, we compared the yield and fruit characteristics of 'Rosal' mirabelle plants with those of two imported certified-virus-free clones ('Nancy 1510' and 'Nancy 1725') not previously cultivated in Spain, with the aim of determining whether, under the same agronomic conditions, they might show better profitability. No information was available on the sensitivity of these clones to *S. purpureum* and *C. beijerinckii*.

Materials & Methods

The study was carried out from 1990-1997 at the 'Do Areeiro' Phytopathology Station located on the southern shore of the Ría de Pontevedra, at 60 m above sea level. Three cultivars of mirabelle plum ('Rosal', 'Nancy INFEL 1510®' and 'Nancy INFEL 1725®') were assayed. For all cultivars, one-year-old nursery-grown grafts on Myrobolan B (*Prunus cerasifera* Ehrh) rootstock were used. Healthy plant material of the 'Rosal' cultivar was carefully selected from local trees and then grafted on Myrobolan B rootstock at the 'Do Areeiro' Phytopathology Station. The improved and certified-virus-free clones 'Nancy 1510' and 'Nancy 1725' were obtained from a commercial supplier in France.

The trial was conducted in a 1500 m^2 plot, with soil properties as follows: texture sandy loam, pH in water 5.7, organic matter 5.3%, Olsen extractable P 82 $\mu g\ g^{-1}$, K^+0.49 cmol(+) kg^{-1}, Ca^{2+} 6.1 cmol(+) kg^{-1}, Mg^{2+} 0.85 cmol(+) kg^{-1}, Na^+ 0.24 cmol(+) kg^{-1}, Al^{3+} 0.30 cmol(+) kg^{-1}. Before preparing furrows for planting, the plot was plowed, harrowed and manured with cattle manure. In May 1987, the three cultivars were established in three blocks, in a randomized complete block design. In each block, one row of trees for each tree cultivar was planted, 5 m apart. Each row contained 8 plants (one guard tree at each end), again 5 m apart. Cultivars were assigned randomly in each experimental block. For each cultivar, each row was considered as a replicate. Spontaneous herbaceous cover was allowed to develop between the plants, and cut regularly, leaving the cuttings on the ground.

Each winter, 300 kg ha^{-1} of calcium superphosphate (18% P_2O_5) and 200 kg ha^{-1} of potassium sulphate was applied. Cattle manure was applied every two years, and 200 kg ha^{-1} of ammonium nitrate (20.5% N) was applied every summer. Irrigation was applied once a week from June to August in all years. Plants were pruned, and dead or damaged branches cut back every year.

Every year (i.e. 1990-1997), fruits were collected by hand from six plants of each row (the end trees were not included), by beating the branches after laying out a tarpaulin on the ground under the canopy (9). In each year, number and weight of fruits produced by each of the plants sampled in that year were recorded for subsequent estimation of mean number and weight of fruits per ha. A random sample of 100 complete fruits from each of the six plants of each row was also taken; these fruits were then pooled and a random sample of 25 fruits was taken for determination of average fruit weight, fruit shape, stone weight, stalk weight and stalk length. In 1990, only the total weight of fruits produced by each plant was recorded. Variation among cultivars was investigated by analysis of variance, with Duncan's Multiple Range Test ($p \leq 0.05$) for mean separation using SAS.

Results

Yield

Fruit yield varied significantly among cultivars, and was consistently lowest for 'Rosal' (Table 1). Overall mean yield (i.e.

Table 1. Mean fruit yeld (kg per plant) and mean number of fruits per kg, for each cultivar in each year of study. Overall means are also shown.

Year	Yield per plant (kg)			No. of fruits per kg		
	Rosal	Nancy 1725	Nancy 1510	Rosal	Nancy 1725	Nancy 1510
1990	0.4 c[Z]	1.4 b	2.7 a	—	—	—
1991	2.7 b	8.1 ab	11.0 a	116 a	105 b	105 b
1992	0.5 b	1.1 ab	3.3 a	118 a	87 b	87 b
1993	—	7.9 a	9.9 a	—	96 a	98 a
1994	9.1 b	35.9 a	47.2 a	157 a	147 b	143 b
1995	2.8 c	21.6 b	32.2 a	141 a	117 b	118 b
1996	12.2 b	68.1 a	83.2 a	96 b	104 a	102 ab
1997	7.3 b	61.8 a	63.2 a	131 a	120 ab	112 b
Overall Mean	5.2 b	27.8 a	31.5 a	128 a	112 b	111 b

[Z]For each variable and within each year, means followed by the same letter do not differ significantly using Duncan's Multiple Range Test ($p \leq 0.05$).

the mean for all years of study) for 'Rosal' was 5.2 kg per annum, versus 27.8 kg per annum for 'Nancy 1725' and 31.5 kg per annum for 'Nancy 1510'. In 1994, all three cultivars showed a clear increase in yield, attributable both to plant maturation and to favorable climatic conditions. From 1994 on, yield of the 'Nancy' cultivars increased, peaking in 1996. Yield of 'Rosal' was erratic and remained much lower, despite the putative preadaptation of this cultivar to local conditions. This could be related to the appearance of *S. purpureum* initially affecting a few branches of the 'Rosal' trees, while 'Nancy' clones were infected but to a much lesser extent. Cumulative yield over the period 1990-1997 was about 80-100 t ha^{-1} for the 'Nancy' plants, much higher than the yield of the 'Rosal' plants over the same period (about 14 t ha^{-1}).

Fruit weight and shape

Data on fruit weight, length, maximum diameter and minimum diameter are summarized in Table 2. The overall mean weight of individual fruits was more than 7 g for all three cultivars. In most years, the mean weight of 'Rosal' fruits was significantly lower than that of 'Nancy' fruits (Table 2), requiring 128 fruit per kg for 'Rosal' as compared to 112 fruit per kg for 'Nancy' clones (Table 1). Similarly, the mean length of 'Rosal' fruits was generally lower than that of 'Nancy' fruits in all but one year in which these variables were determined. However, there was no clear pattern of variation in maximum and minimum diameter.There were clear differences in the frequency distribution of fruit weights (Figure 1). Considering the eight-year mean, only ~20% of the 'Rosal' fruits weighed more than 10 g, versus ~40% of 'Nancy' fruits. Neither stalk length (mean 12.4 mm) nor stalk weight (mean 0.03 g) varied significantly among cultivars (data not shown).

Stone weight and shape

Data on stone weight and shape, together with estimates of percentage edibility, are summarized in Table 3. Overall mean stone weight was significantly higher for 'Nancy' than for 'Rosal'. Overall mean stone length was also significantly higher for 'Nancy'. However, overall mean maximum and minimum stone diameters differed little between 'Rosal' and 'Nancy 1510', and were both higher in 'Nancy 1725'. The overall mean percentage edibility of 'Rosal' and 'Nancy 1510' was ~94.7%, versus ~93.7% for 'Nancy 1725'.

Discussion

Our results clearly show that 'Nancy' gave higher yields, and produced larger

Table 2. Mean characteristics (weight, length, maximum diameter and minimum diameter) of the fruits of each cultivar in each year of study. Overall means are also shown.

	Weight (g)			Length (mm)			Maximum diameter (mm)			Minimum diameter (mm)		
Year	Rosal	Nancy 1725	Nancy 1510	Rosal	Nancy 1725	Nancy 1510	Rosal	Nancy 1725	Nancy 1510	Rosal	Nancy 1725	Nancy 1510
1990	5.3 a[Z]	6.6 a	6.3 a	—	—	—	—	—	—	—	—	—
1991	8.6 b	9.5 a	9.5 a	23.9 b	24.7 ab	25.1 a	25.8 a	25.0 a	24.8 a	23.4 a	24.0 a	23.0 a
1992	8.5 b	11.5 a	11.0 a	23.4 b	25.9 a	26.0 a	23.5 b	26.0 a	25.9 a	22.7 b	25.2 a	24.8 a
1993	—	10.6 a	10.3 a	—	25.6 a	25.0 a	—	25.3 a	25.1 a	—	25.0 a	24.3 a
1994	6.3 b	6.9 a	7.0 a	21.2 b	21.9 ab	23.0 a	22.1 a	21.9 a	22.5 a	21.1 a	21.4 a	21.9 a
1995	7.2 b	8.6 a	8.8 a	22.0 b	23.6 a	23.9 a	22.1 a	23.0 a	23.1 a	20.8 a	22.2 a	22.1 a
1996	10.5 a	9.6 b	9.8 b	24.7 a	25.3 a	24.7 a	26.0 a	24.7 b	25.2 b	25.3 a	24.3 b	24.4 b
1997	7.7 b	8.5 ab	9.1 a	23.0 a	23.5 a	24.2 a	22.8 a	23.5 a	24.2 a	21.3 b	22.3 ab	22.7 a
Overall Mean	7.7 a	9.0 a	9.0 a	23.2 a	24.3 a	24.5 a	23.9 a	24.1 a	24.3 a	22.7 a	23.4 a	23.4 a

[Z]For each variable and within each year, means followed by the same letter do not differ significantly using Duncan's Multiple Range Test ($p \leq 0.05$).

Table 3. Mean stone characteristics (weight, length, maximum diameter and minimum diameter) of the fruits of each cultivar in each year of study. Percentage edibility is the percentage of fruit weight not due to stone, calculated independently for each fruit. Overall means are also shown.

	Weight (g)			Length (mm)			Maximum diameter (mm)			Minimum diameter (mm)			Percentage edibility (%)		
Year	Rosal	Nancy 1725	Nancy 1510	Rosal	Nancy 1725	Nancy 1510	Rosal	Nancy 1725	Nancy 1510	Rosal	Nancy 1725	Nancy 1510	Rosal	Nancy 1725	Nancy 1510
1991	0.4 b[Z]	0.4 a	0.4 a	12.2 b	13.1 a	13.2 a	9.7 a	10.2 a	10.0 ab	6.4 b	7.0 a	6.5 ab	95.5 a	95.0 b	95.2 b
1992	0.4 c	0.5 a	0.5 b	12.5 b	14.0 a	13.7 a	9.9 a	10.8 a	11.0 a	6.1 b	6.6 a	6.5 a	95.2 a	95.6 a	95.4 a
1993	—	0.5 a	0.5 a	—	13.4 a	13.2 a	—	10.5 a	10.0 a	—	6.6 a	6.2 a	—	94.5 a	94.4 a
1994	0.3 b	0.3 a	0.3 ab	11.7 a	12.8 a	12.5 a	9.4 a	9.4 a	9.3 a	5.9 a	6.1 a	6.1 a	94.8 ab	94.5 b	94.9 a
1995	0.4 a	0.5 a	0.4 a	12.5 b	13.5 a	13.0 ab	9.4 b	10.2 a	9.8 ab	6.0 b	6.5 a	6.1 b	93.7 a	87.9 b	94.6 a
1996	0.5 b	0.5 ab	0.5 a	12.7 b	13.5 a	13.3 a	10.2 b	10.5 a	10.2 b	6.4 a	6.5 a	6.5 a	95.0 a	94.4 b	94.4 b
1997	0.4 b	0.5 ab	0.5 a	12.7 b	13.0 b	13.5 a	9.7 b	10.1 a	10.2 a	6.2 b	6.3 a	6.4 a	94.2 a	94.2a	94.3 a
Overall Mean	0.4 b	0.5 a	0.5 a	12.4 b	13.3 a	13.1 a	9.8 b	10.2 a	10.0 ab	6.2 b	6.5 a	6.3 b	94.7 a	93.7 b	94.7 a

[Z]For each variable and within each year, means followed by the same letter do not differ significantly using Duncan's Multiple Range Test ($p \leq 0.05$).

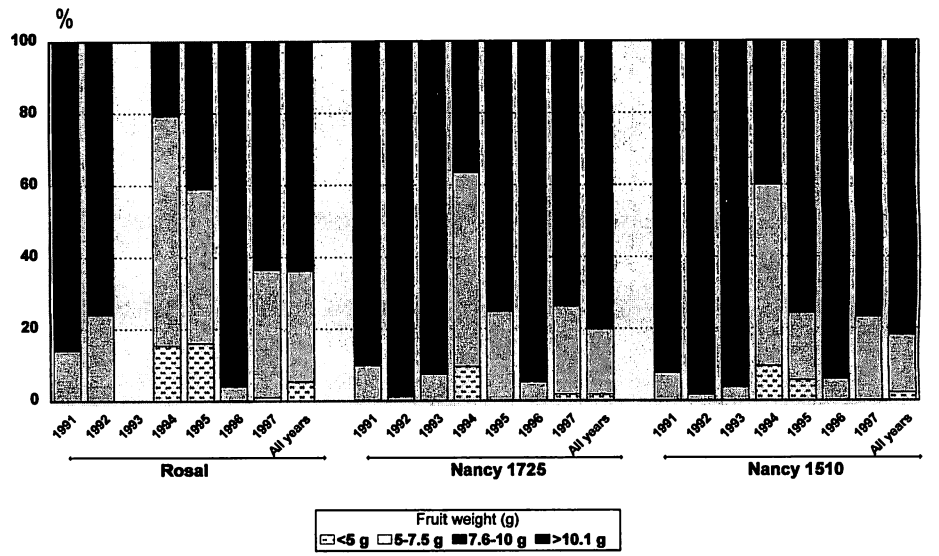

Figure 1. Frequency distribution of fruit weights. The distributions of the pooled data for each cultivar are also shown.

fruit, than 'Rosal'. The 'Nancy' cultivars thus adapted well to the climate of the study area, and yield increased steadily with age. By contrast, 'Rosal' gave particularly poor yields in some years, and in 1993 did not produce any crop. At peak production, annual yields of mirabelle plum plants have been reported to be 60-80 kg per tree by year 7 (4,9). Yields obtained in the last two years of the present study from 'Nancy' plants (Table 1) were thus within the expected range for mature plants, while the yields obtained for 'Rosal' plants were clearly deficient. These differences may be of genetic origin. The Nancy clones are the result of a systematic selection and disease-control program, while the 'Rosal' material is from old trees which have not been subjected to any improvement. Although not quantified, different yields could also be attributable to the impact of *Stereum purpureum* in the local cultivar.

Mirabelle plums typically show alternate bearing (3,4,6), i.e. good years of fruit production alternating with poor years. Excess fruit production leads to a reduction in the number of flower buds in the following season. In the present study, we found that the between-consecutive-year difference in yield of individual 'Nancy' plants was generally 7-20 kg; this is at the low end of the 5-100 kg range reported by Gerst (3) to be normal. The relatively minor alternate bearing tendency may be attributable to the high soil nutrient levels and to good plant health. The yields of our 'Rosal' plants were too low to permit meaningful evaluation of alternate bearing.

The mean weight of individual 'Nancy' fruits was consistently higher than that of 'Rosal' fruits, although lower than those reported previously. Gigleux (5) reported that mean fruit weight is typically 10-15 g for 'Nancy 1510' plants and 12 g for 'Nancy 1725' plants. The relatively low mean fruit weights obtained in the present study may be attributable to the summer drought characteristic of our region, which typically coincides with the period of fruit growth. The irrigation which was applied throughout the study, may have been insufficient to ensure optimal soil moisture.

Our data on the length, maximum diameter and minimum diameter of fruits show

that 'Rosal' plums were typically rounded in shape, whereas 'Nancy' plums were more elongated. This result contrasts with previous reports which have described 'Nancy' mirabelle plums as rounded (5,7), though the INRA document (7) remarks that the fruits of these cultivars may be slightly elongated. The apparent contradiction between our results and those of Gigleux (5) may be attributable to the difference in fruit length: in all years of study, we obtained mean fruit lengths of about 24-25 mm for both 'Nancy 1510' and 'Nancy 1725' plums. This contrasts with the greater interannual variation found by Gigleux (5), who reported annual means of 25-29 mm. His reported differences in shape are attributable only to differences in length, since data on maximum diameter and minimum diameter were not reported in these previous studies. In any case, the 'Nancy' fruits produced in the present study met the minimum length for marketing in France (22 mm) (8). The high absolute maximum values reported by Gigleux (5), with some fruits up to 29 mm in length, were not recorded in the present study, in which the absolute maximum values were 26 mm for 'Nancy 1510' and 'Nancy 1725' fruits.

Our data on stone weight indicate that percentage edibility was practically the same for 'Nancy' and 'Rosal' fruits. The mean minimum diameter of the stones of 'Nancy' fruits was on average smaller than reported by Gigleux (5), but our stones were on average longer, and in fact percentage edibility was lower than that of the fruits described by Gigleux.

In conclusion, the results of the present study confirm that it is possible to increase production of mirabelle plums in northwest Spain by introducing 'Nancy' cultivars 1510 and 1725. Further research is needed to look for ways of improving other aspects of cultivation, such as the most suitable grafting stocks, appropriate fertilization and particularly the phytosanitary problems observed in this species. The optimization of these factors may help to further improve mirabelle yield and fruit quality.

Literature Cited

1. Bailey, L.H. 1963. The Standard Cyclopedia of Horticulture. Vol III. MacMillan, New York, 1217 p.
2. Carballeira, A., C. Devesa, R. Retuerto, E. Santillán, and F. Ucieda. 1983. Bioclimatología de Galicia. Fundación Pedro Barrio de la Maza, La Coruña, Spain, 391 p.
3. Defaix, T. 1994. Une deuxième vie económique. L'Arboriculture Fruitière 469: 27-30.
4. Gerst, J.J. 1976. Le Mirabellier. INVUFLEC, Paris, 76 p.
5. Gigleux, C. 1994. Les nouveaux verger. L'Arboriculture Fruitière 469: 20-25.
6. Gigleux, C. 1996. La Mirabelle. Monographie CTIFL, Arefe, Paris. 211 p.
7. INRA. 1969. Fiche variétale Mirabelle de Nancy. Observations INRA, Station de Recherchers d'Arboriculture Fruitière de la Grande Ferrade, Pont de la Maye, France.
8. Kaluzny-Pinon, L. 1995. Operation mirabelles en Lorraine. Une belle unanimité. L'Arboriculture Fruitière 483: 31-33.
9. Salinero, M.C., J.P. Mansilla, R. Vázquez, and A. Abelleira. 1986. El Mirabel: Monografia. Servicio Agrario, Diputación Provincial de Pontevedra, Pontevedra, Spain, 42 p.