1/3, or 1/4 without appreciable loss of precision. We may also use the previous trial to further illustrate the way in which the field plan can be modified to increase precision and reduce the size of a test. It was planted in 3 replications of 4-vine plots. If 10 cvs. were used, 120 vines are required for the test and a detectable difference of 11.05 kg (24.36 lbs.)/vine could be detected in 80% of the experiments. By using 8 replications of 1-vine plots only 80 vines are required and a difference of 7.33 kg (16.18 lbs.)/vine can be detected in 80% of the cases. With 8 replications of 1-vine plots the total no. of plants is reduced by 33% and the detectable difference is reduced by 3.71 kg (8.19 lbs.)/vine.

The effect of the no. of cvs. being tested on the precision of the trial is illustrated in Fig. 3. As the no. of replications increases, the effect of the no. of cvs. on the detectable difference decreases. Only when there were fewer than 10 cvs. and/or less than 4 replications did the no. of cvs. appreciably affect the detectable difference.

With 1-vine plots, missing vines will imply complete loss of information for some plots. The disproportionality resulting from the missing data will be no problem in the analysis since missing plot information can be calculated automatically with present computer programs.

When one plans a cv. trial, an increase in replication is relatively easy to obtain and the added precision gained by increasing replications and decreasing plot size is well worth the effort. The total size of the test is almost proportional to the cost of a trial and can be reduced while detecting smaller differences in yield through an increase in replications and a decrease in plot size.

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Effects of Rootstock on Leaf Element Content of 'Italian' Prune (*Prunus domestica* L.)[1]

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Abstract. Plantings of the 'Italian' prune (*P. domestica* L.) were established on seedling peach (*P. persica* L. Batsch) and clonal Myrobalan 29-C, B, 2-7 (*P. cerasifera,* Ehrh.); Marianna 4001, 2623, 2624 (*P. cerasifera* x Munsoniana?, Wight and Hedr.); and St. Julien A (*P. insititia* L. Bullace) rootstocks in 7 orchard sites in Oregon. Leaf samples were collected in the years 1968 to 1970 and analyzed for element content. Trees with plum rootstocks had greater leaf N, K, Mn, and Zn and slightly less B and Mg than those on peach. Plum clones, Myrobalan 29-C, Myrobalan B, and St. Julien A, were more efficient in the uptake of Ca. There were positive correlations between N and Ca, N and Mg, N and B, N and Zn, Ca and Mg, Ca and B, and Mg and B for most of the stocks. There was a negative correlation between K and Mg for Myrobalan 2-7 and the 3 Marianna clones. Myrobalan B and Marianna 2623 and 2624 had a negative corrleation for K and Ca whereas St. Julien A had a positive correlation.

The major weakness of 'Italian', the principal prune cv. of the Northwest, is the tendency for irregular bearing. One factor contributing to this irregular production has been the frequent occurrence of nutrient deficiencies. A 1964 survey of 177 'Italian' prune orchards in western Oregon indicated that 77% were deficient in N, 64% in B, and 15% in K based on critical values of 1.8%, 1.5%, and 30 ppm for N, K, and B (12). All trees included in this survey were on peach, the predominant rootstock for prune in western Oregon.

Rootstock has been shown to influence the nutritional status of a number of deciduous tree fruit species (2, 6, 7, 9, 10, 13, 14). Little information is available, however, on the effects of various rootstocks on the nutrition of 'Italian' prune. Evaluations of plum rootstocks in California have shown Myrobalan and Marianna to be widely adapted to different soil types and moisture conditions, and peach to be best suited to well drained sandy loam soils (8). Most western Oregon soils are fine textured clay loams and in many cases are not well drained. Hansen (5) reported that 'French' and 'President' plums on almond (*P. amygdalus,* Batsch) and Myrobalan roots were less effective than on peach in the absorption of B, and hence would be less susceptible to B toxicity.

The purpose of this study was to determine the nutritional status of the 'Italian' prune on various rootstocks under a number of soil and environmental conditions with the objective of finding a rootstock(s) less susceptible to nutrient deficiencies and more efficient in nutrient absorption.

Materials and Methods

The following rootstocks were used: Myrobalan 29-C, B, 2-7; Marianna 4001, 2623, 2624; St. Julien A; and 'Lovell' peach seedling. The Myrobalan B and St. Julien A stock plants were obtained from the East Malling Research Station, Kent, England and the remaining plum clones from the University of California, Davis.

The plum rootstocks were propagated from softwood cuttings and the seedling 'Lovell' peach rootstocks, budded with 'Italian' prune, were obtained from commercial nurseries. The plum rootstocks were grown for one year in the nursery and budded with 'Italian' prune. The 'Italian' prune buds were obtained from a single certified virus-free tree. The budded trees were grown for one year prior to planting in the experimental plots.

The experimental plots were established in 7 commercial orchards in western Oregon. Soil types could generally be classified as clay loams with moderate to good soil drainage. Soil pH varied from 5.8 to 6.4. The plots were established in the spring of the following years: plots 1, 4, 5, and 6 - 1963; plots 3

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and 7 - 1965; and plot 2 - 1966. Each plot consisted of 7-10 single-tree randomized blocks. Maintenance of the plots was assumed by the individual growers after planting.

Leaf samples were collected from plots 1, 2, and 3 in 1968, 1969, and 1970; and plots 4, 5, 6, and 7 in 1969 and 1970. The leaf samples were collected from mid-terminal shoots in mid-August, washed in a detergent solution (1), dried at 70°C, and ground to pass a 40 mesh screen. Total N was determined on a Technicon Auto-Analyzer (4). Potassium, Ca, Mg, Mn, B, and Zn were determined on a Jarrell-Ash 3/4 Meter Direct

Table 1. Leaf element content of 'Italian' prune as related to rootstock at each location, 1968-1970[z].

Rootstock	Element	Plots 1	2	3	4	5	6	7	Mean	Plot differences[y]
					Percent dry wt					Percent
Peach	N	1.77	2.15	2.16	2.28	2.57	2.00	2.00	2.13	–
Myro. 29-C		2.46	2.61	2.38	2.74	2.85	2.49	2.33	2.55	86
Myro. B		2.32	2.55	––	2.70	2.36	2.44	2.31	2.47	83
Myro. 2-7		2.31	2.63	2.45	2.60	2.55	2.39	2.28	2.46	43
Mar. 4001		2.42	2.78	2.16	2.58	2.84	2.46	2.22	2.49	57
Mar. 2623		2.28	2.29	––	2.43	2.54	2.37	1.90	2.30	33
Mar.2624		2.27	2.50	2.12	2.68	2.57	2.53	1.84	2.36	57
St. Jul. A		2.52	2.70	2.50	––	––	––	2.23	2.49	75
LSD (.05)		.31	.35	.34	.38	.25	.26	.31		
Peach	K	1.86	1.76	2.63	1.87	1.20	2.20	2.36	1.98	–
Myro. 29-C		2.54	2.19	2.29	2.04	1.82	2.58	2.39	2.26	57
Myro. B		2.48	1.72	––	2.05	1.08	2.42	2.24	2.00	17
Myro. 2-7		3.13	2.16	2.98	2.10	1.58	3.10	3.04	2.58	57
Mar. 4001		2.46	1.94	1.82	1.68	1.41	2.50	2.42	2.03	29
Mar. 2623		2.62	2.55	––	1.79	1.08	2.55	2.73	2.22	67
Mar. 2624		2.37	2.16	2.30	1.98	1.17	2.73	2.48	2.17	29
St. Jul. A		3.21	2.18	2.97	––	––	––	2.92	2.82	75
LSD (.05)		.47	.41	.59	NS	.13	.33	.15		
Peach	Ca	1.48	2.05	1.64	1.61	2.58	1.60	1.56	1.79	–
Myro. 29-C		1.77	1.83	1.44	1.80	2.47	1.49	1.54	1.76	14
Myro. B		2.16	2.65	––	1.99	3.14	1.78	1.67	2.23	50
Myro. 2-7		2.36	2.42	1.93	2.13	3.04	1.66	1.84	2.20	57
Mar. 4001		1.82	1.91	1.55	1.92	2.61	1.48	1.60	1.84	14
Mar. 2623		1.69	1.93	––	2.07	2.70	1.41	1.70	1.92	0
Mar. 2624		1.63	1.68	1.52	2.13	2.39	1.58	1.61	1.79	0
St. Jul. A		2.19	2.14	2.02	––	––	––	1.74	2.02	50
LSD (.05)		.29	.36	.28	NS	.29	.27	NS		
Peach	Mg	.42	.56	.39	.44	.57	.46	.40	.46	–
Myro. 29-C		.40	.47	.30	.46	.64	.38	.35	.37	29
Myro. B		.47	.62	––	.58	.60	.48	.41	.53	0
Myro. 2-7		.48	.55	.37	.49	.56	.41	.41	.47	14
Mar. 4001		.39	.47	.34	.48	.59	.38	.40	.44	14
Mar. 2623		.39	.44	––	.51	.56	.38	.38	.44	17
Mar. 2624		.37	.42	.34	.50	.62	.38	.37	.43	14
St. Jul. A		.37	.44	.34	––	––	––	.34	.37	25
LSD (.05)		.06	.08	.08	NS	.11	.07	NS		
					Parts per million dry wt					
Peach	Mn	47	19	66	112	25	50	63	55	–
Myro. 29-C		94	40	102	148	41	79	127	90	57
Myro. B		122	39	––	136	40	66	77	80	50
Myro. 2-7		116	36	93	174	40	65	91	88	43
Mar. 4001		91	44	101	167	38	88	102	90	43
Mar. 2623		82	39	––	156	37	74	81	78	50
Mar. 2624		125	46	136	211	47	126	138	118	100
St. Jul. A		106	30	126	––	––	––	93	89	50
LSD (.05)		55	7	44	64	9	19	48		
Peach	B	32	37	36	31	49	32	36	36	–
Myro. 29-C		32	32	28	31	44	31	34	33	29
Myro. B		31	33	––	32	38	30	35	33	33
Myro. 2-7		33	33	37	31	40	30	36	34	29
Mar. 4001		33	32	28	30	45	32	36	34	29
Mar. 2623		33	32	––	27	44	32	34	34	17
Mar. 2624		32	31	26	28	42	30	34	32	43
St. Jul. A		31	31	36	––	––	––	35	33	25
LSD (.05)		NS	4	5	NS	7	NS	NS		
Peach	Zn	11	21	19	26	13	19	11	17	–
Myro. 29-C		17	31	27	28	21	28	16	24	71
Myro. B		14	30	––	22	21	26	14	21	86
Myro. 2-7		14	24	22	24	17	22	10	19	29
Mar. 4001		16	31	22	24	21	26	13	22	57
Mar. 2623		16	23	––	22	23	23	11	20	33
Mar. 2624		18	28	21	23	25	25	13	22	57
St. Jul. A		16	32	21	––	––	––	13	20	50
LSD (.05)		3	7	NS	NS	2	6	4		

[z] Locations 1-3 sampled 1968-1970.
Locations 4-7 sampled 1969-1970.

[y] Represents percent of total number of plots that the indicated plum rootstock differed from the peach at the 5% level.

Reading Photoelectric Spark Emission Spectrometer.

The data from each plot were subjected to analysis of variance in a year x rootstock factorial. Because of its predominance in the western Oregon prune industry, the peach rootstock was used as the standard for comparison.

Results and Discussion

To facilitate comparisons of peach and plum rootstocks, in addition to leaf element content (Table 1), the data were expressed as the percentage of the total no. of plots that a plum rootstock differed from peach ($P = .05$) for a specific element (last column of Table 1) and leaf element content of a plum rootstock expressed as a percent deviation from that of trees on peach (Table 2).

In general, trees on plum rootstocks had greater leaf N, K, Mn, and Zn and slightly less B and Mg than those on peach (Tables 1 and 2). Plum clones, Myrobalan 29-C, Myrobalan B, and St. Julien A were more efficient than peach in the uptake of Ca. Nitrogen and K leaf contents for trees on plum rootstocks were from 9 to 20% and 1 to 34% higher than those on peach, respectively (Table 2). It is possible that use of the appropriate plum rootstock would result in a reduction of the amount of N and K fertilizers required for maintenance of adequate nutritional status or reduction of these deficiencies. A decrease in the fertilizer requirement as a result of an increase in the efficiency of nutrient uptake should help prevent pollution of ground water with chemical fertilizers.

Table 2. Leaf element content of 'Italian' prune, as related to rootstock, expressed as a percent deviation from the peach rootstock.

Rootstock	Element N	K	Ca	Mg	Mn	B	Zn
	Percent deviation from peach[z]						
Myro. 29-C	20	18	0	-8	74	-8	44
Myro B	16	1	23	11	67	-7	30
Myro 2-7	16	31	21	1	67	-4	12
Mar. 4001	18	5	1	-6	74	-6	31
Mar. 2623	9	12	6	-6	57	-6	23
Mar.'2624	11	10	2	-7	123	-11	34
St. Jul. A	24	34	16	-14	81	-6	31

[z] Mean of the 7 locations.

Table 3. Correlation coefficients[z] for element pairs for rootstocks over all plots.[y]

Correlated Elements		Rootstock Peach	Myro. 29-C	Myro. B	Myro. 2-7	Mar. 4001	Mar. 2623	Mar. 2624	St. Jul. A
N	K				-.32		-.38		
N	Ca	.57	.49		.28	.51	.42	.41	.35
N	Mg	.29	.50	.31	.36	.48	.49	.37	.38
N	Mn	.30							
N	B	.36	.32	.37	.32	.47	.36	.36	
N	Zn	.38		-.37	.46		.43	.49	.46
K	Ca						-.36	-.36	.48
K	Mg			.32	-.39	-.29	-.54	-.64	
K	Mn	.42		-.29					
K	B	-.28						-.28	
K	Zn						-.30		-.35
Ca	Mg	.40	.75		.80	.77	.81	.69	.80
Ca	Mn								
Ca	B	.56	.46	.40	.27	.54	.50	.34	
Ca	Zn								
Mg	Mn						.80		
Mg	B		.68		.44	.71	.57	.50	
Mg	Zn	.28		.28			.33		
Mn	B								
Mn	Zn	.43							
B	Zn								

[z] Significant at the 1% level as determined from Table A 11 (11) using the appropriate D.F.

[y] For the years 1969 and 1970 combined.

The lower B values for plum rootstock clones relative to peach, agree with Hansen's report (5) that 'French' prune was more susceptible to B toxicity when on peach than when on Marianna or Myrobalan. The lower B values found for the plum clones, while not desirable in areas of widespread B deficiency, are not considered a serious drawback because of the relative ease of detection of B deficiency through leaf analysis and its correction with foliar sprays.

Manganese levels, while considerably higher with some plum stocks, were not high enough to be toxic.

The higher leaf Zn (12-44%) of trees on plum stocks could help prevent Zn deficiency in alkaline soils such as occur in eastern Oregon and other areas of the West. Additional plots have been established to test this hypothesis.

There were positive correlations between N and Ca, N and Mg, N and B, N and Zn, Ca and Mg, Ca and B, and Mg and B for most of the stocks (Table 3). For 4 of the stocks (Myrobalan 2-7 and the 3 Marianna clones) there was a negative correlation between K and Mg. Myrobalan B, Marianna 2623, and Marianna 2624 had negative correlations for K and Ca but St. Julien A had a positive correlation. This was the only case where the sign of the correlation between 2 elements changed with rootstock. While some of the correlations were not high, even though highly significant, the consistency of the positive correlations between N and Ca, N and Mg, and the negative correlations between N and K, K and Ca, and K and Mg agree with previously published reports on prune and other tree crops as cited by Emmert (3). There were several cases when a correlation was or was not observed in a majority of the rootstocks. These could be attributed to differences in species or adaptation to a particular climate and soil type from which the rootstocks were originally selected. These relationships, along with the individual nutrient intensities, may have a bearing on fertilizer practices as related to rootstock, but the cause and effect relationships must be determined by further study.

Rootstock effects on fruit yield, fruit quality, and tree growth dynamics are being studied. These factors will be considered together with nutrition, and their interrelationships evaluated before rootstock recommendations are made.

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Three Years' Results with Chemical Thinning of Peaches with (2-chloroethyl)phosphonic Acid[1]

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Abstract. Three years' investigations of ethephon sprays for thinning of 'Redskin' and 'Redhaven' cvs. are summarized. In screening, thinning without foliage injury was achieved up to about 3 weeks after full bloom at concn up to 300 ppm. Field experiments tended to confirm screening results. Within timing used, satisfactory thinning was accomplished most often during blossoming. Foliage injury generally increased as application was delayed and as concn increased. Fruit size at harvest was increased more by blossom treatments than later application. Fruit abscission occurred quickly after spraying. Ethephon is most promising as a peach thinning chemical, but time-dosage curves within acceptable injury limits are not yet established.

In 1968, we screened (2-chloroethyl)phosphonic acid[2] (ethephon) on limb-units for thinning potential on 'Redskin' and 'Redhaven' trees at concn of 50 to 800 ppm, applied on 6 dates ranging from 20% bloom to 44 days after full bloom (FB) at a mean ovule length of 9.8 mm. Striking thinning was achieved, but only at the expense of unacceptable foliage injury and abscission when applied after Stage VII of fruit development (6).[3] Results warranted full-scale orchard experiments at concn of 300 ppm or less, applied not later than Stage VIII. This paper summarizes 3 year's investigations with 'Redskin' and 'Redhaven' cvs.

Materials and Methods

Experiments were conducted in the University orchard at College Park, and in commercial orchards near Hancock, Maryland. All trees used were moderately vigorous, were pre-selected for uniformity of vigor and potential crop, and ranged in age from 5 to 16 years in 1969. Pre-bloom bud counts were made on 3 representative limbs per tree, and totaled 800-1000 buds per tree. Fruit counts were taken after final drop in mid-June to assess thinning responses; following counting, trees were thinned by hand as needed. Because of bulk bin harvesting, yield records are no longer possible in most commercial orchards. Thus, fruit circumference measurements were made on 25 fruits per tree immediately prior to first harvest; these were converted to vol assuming the fruit to be a sphere. Effective thinning without injury to foliage is reflected in fruit size, and the circumference data were taken to supplement fruit set data, except where obvious over-thinning had occurred. All ethephon treatments included Tween 20[4] at 1 pt/100 gal, and were applied to runoff with hand guns at 550 psi. Each experiment was a randomized complete block with single-tree plots replicated 5 times.

Results and Discussion

'Redhaven'. At College Park, 1969, drastic thinning on young trees resulted from blossom treatments, good thinning at Stage III with 150 ppm, little thinning at Stage VIII (Table 1). On 16-year-old trees, similar concn were somewhat less effective in post-bloom thinning. On young trees severe arrest of foliage growth occurred from 100 ppm at blossoming, and from Stage III treatments on young trees. This was not accompanied by defoliation, and recovery began in 2 weeks. Stage VIII treatments resulted in similar depression of foliage, and also in considerable defoliation 2 weeks later. On older trees, all but the 75 ppm concn arrested foliage without defoliation. Fruit drop from the 100 ppm spray on young trees occurred in 4 days, whereas that from all other treatments in both experiments was observed 9 to 12 days after spraying. On young trees fruit size at harvest was greatly increased from blossom sprays which overthinned, but not from post-bloom sprays which thinned less, but significantly. Despite the overthinning by the 50 ppm spray, yield was not significantly lower than that of check trees, whereas late sprays (Stage VIII) of 225 ppm had no effect on fruit size, yet decreased yield significantly. On older trees, significant thinning by post-bloom sprays was accompanied by increased fruit size in only 1 out of 4 instances.

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[2] Ethephon was supplied by Amchem Products, Inc., as formulation 66-329 in 1968, and as Ethrel thereafter.

[3] Development stages proposed by Lott and Simons refer to specific changes in floral tube and styler abscission occurring within about 3 weeks after FB. These should not be confused with long-used reference to fruit development: i.e. Stage I - initial growth, Stage II - pit hardening, and Stage III - final swell.

[4] Polyoxyethylene sorbitan monolaurate.