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State Research Station Blangstedgaard (Dir. E. Poulsen)

The Nutritional State of Danish Fruit Orchards as Shown by Leaf Analysis. II. Pears, Cherries and Plums 1967-70

Ernæringstilstanden i danske frugtplanter, belyst ved bladananalyser II. Pære, kirsebær og blomme 1967-70

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Summary

During 1967-70, leaf samples from danish pear, cherry and plum orchards were analyzed for N, P, K, Ca, Mg, B, and Mn. The nutritional state was found to be satisfactory except for potassium, were some degree of excess was found. There is good agreement between the results of this test and those from other countries. The material shows the possibility of predicting optimal values for the leaf analysis of the three species adapted to danish conditions. In interpreting the leaf analysis, consideration must be given to the actual yield level, the type of soil, the cultivar variation and to antagonistic conditions, especially between potassium- and magnesium-calcium.

Table 1

Nutritional state of fruit trees in different growing areas

Litt. no.	Fruit	Growing area	Leaf Analysis, part of Dry Matter % N	P	K	Ca	Mg	ppm B	Mn	Leaf materials
9	Pear	U.S.A.	2.74							spore leafs
1		Ontario	2.05	0.17	1.04					leafs from present
11		Michigan	2.50	0.14	1.45	1.90	0.40	23	133	years growth, middle
4		France	2.21	0.16	0.96	1.86	0.28	—		»
13		Germany	—	0.17	2.05	1.73	0.29	—		»
20		California	1.95	0.12	1.00	1.35	0.60	—		» , basal
19		California	1.95	0.11	0.80	1.50	1.05	—		» , middle
1	Cherry	Ontario	2.41	0.23	1.49	1.80	0.50	—		leafs from present
16		Norway*	3.52	0.29	1.94	1.28	0.39	51	72	years growth, middle
11		Michigan	2.83	0.27	1.54	1.91	0.74	67	114	»
23		Pennsylvania	2.57	0.19	1.16	1.51	0.61	36	72	»
25		England	2.21	0.26	1.58	2.14	0.22	—		»
5		Switzerland	2.79	0.21	2.08	1.16	0.24	—		»
12		New York	2.18	—	1.17	—	0.45	—		»
14	Plum	U.S.A.	—	—	3.40	3.43	0.91	—		spore leafs
15		Norway	2.60	—	—	—	—	—		leafs from present
26		Norway	2.50	—	2.54	1.66	0.35	—		years growth, middle
20		California	2.25	0.15	1.45	2.00	1.25	—		»

* Sweet cherries

Table 1 a

Leaf Analysis, tentative optimal level
Percent of Dry Matter

	N	P	K	Ca	Mg	ppm B	ppm Mn
Pear.....	2.0–2.5	0.15–0.25	1.2–1.6	1.2–2.0	0.20–0.30	20–50	30–150
Cherry.....	2.6–3.2	0.20–0.40	1.5–2.0	1.2–2.0	0.20–0.30	20–50	30–150
Plum	2.4–2.8	0.20–0.40	2.0–2.5	1.2–2.0	0.20–0.30	20–50	30–150

Introduction

In 1963 a cooperative project was established between Blangstedgaard State Research Station and advisors in D.E.F. (Danish Fruitgrowers Association) with the object of analyzing leaf samples from representative danish apple orchards. As a continuation of this work, samples were taken from pear, cherry and plum orchards during 1967-70. As in the first investigation *(Vang-Petersen et al.* 1973) the purpose was to evaluate the nutritional state and to get a basis for establishing optimal levels for the individual nutrient adapted to danish conditions. While a large amount of similar research has been performed in other countries for apples, there is very little comparative information for pears, cherries and plums. Some results from different countries are shown in Table 1.

Just as for apples, there is no universal table of the optimal level for pears, cherries and plums: however, a few suggestions have been made *(Beyers* 1962). In addition further guidelines can be drawn from fertilizer experiments *(Fritzsche et al.* 1964) On the basis of these the following tentative optimal levels are proposed for evaluation of the leaf samples. Terminology concerning deficiency levels, optimal levels and excess levels is described in *Vang-Petersen et al.* (1973).

Materials and methods

Leaf samples were taken from representative fruit orchards every year during 1967-70. The geographic location and distribution of the samples collected is shown in Table 2.

Pear samples were collected from 12 orchards with 'Conference', 25 with 'Clapps Favorite', 8 with 'Clara Frijs' and 12 with other varieties. Cherry samples were collected from 8 orchards with 'Skyggemorel', 4 with 'Kelleris', and 26 with 'Stevnsbær'. Plum samples were collected from 10 orchards with 'Kirkes', 6 with 'Opal', 5 with 'Italien Prune' and 5 with 'Reine Claude Althans' or other cultivars. The 121 orchards were distributed with 47 on heavy, 51 on medium-heavy, and 23 on light soil type.

Table 2

Leaf samples, location and distribution

	total number of orchards	Sjælland Lolland + Falster	Fyn	Jylland	orchards with samples each year
Pear	57	28	9	20	35
Cherry ..	38	19	9	10	17
Plum....	26	12	5	9	15

Leaf samples were taken between August 1 and September 15. The leaves were picked without petiole, from the middle third of the present years growth with 75 to 100 leaves per samples taken from at least 25 trees. The leaf dry matter was analyzed for N, P, K, Ca, Mg, B, and Mg. Total nitrogen (N) was measured by micro-kjeldahl method, potassium (K) and calcium (Ca) by flame photometric, magnesium (Mg) complexometric, phosphorus, (P) by vanadomolybdat method. In addition, a number of samples were analyzed for boron (B) by the diantrimid method and manganese (Mn) by colorimetric method.

Analysis of the samples was performed at Blangstedgaard and Statens Planteavls-Laboratorium, Vejle. Statistical analysis was per-

Table 3

Yearly average nutrient content in leaves from orchards sampled in all four years*

Fruit	Year	Leaf analysis, part of Dry Matter % N	P	K	Ca	Mg	ppm B	Mn
Pear	average 1967–70....	2.49	0.18	1.65	1.76	0.25	23	
	1967.....	2.46	0.19	1.74	1.56	0.23	22	
	1968.....	2.46	0.17	1.75	1.74	0.22	22	
	1969.....	2.46	0.17	1.65	1.86	0.26	25	40
	1970.....	2.56	0.18	1.46	1.89	0.28	24	
	LSD_{95}	0.09	0.01	0.10	0.14	0.02	—	
	cV %	7.5	10.4	13.0	16.5	15.4	—	
Cherry	average 1967–70....	3.13	0.22	1.98	2.10	0.36	43	
	1967.....	2.98	0.21	2.02	1.86	0.31	42	
	1968.....	3.23	0.24	2.09	2.20	0.34	42	
	1969.....	3.12	0.22	1.96	2.04	0.39	45	43
	1970.....	3.22	0.23	1.84	2.32	0.42	43	
	LSD_{95}	0.20	0.02	0.16	0.23	0.05	—	
	cV %	9.2	11.1	11.7	15.6	18.9	—	
Plum	average 1967–70....	2.58	0.25	2.92	2.15	0.34	31	
	1967.....	2.63	0.25	2.69	2.05	0.33	30	
	1968.....	2.62	0.24	3.04	2.09	0.31	29	
	1969.....	2.54	0.21	2.97	2.09	0.34	33	38
	1970.....	2.55	0.24	2.96	2.39	0.37	31	
	LSD_{95}	0.21	0.02	0.19	0.17	0.02	—	
	cV %	11.1	11.5	8.8	11.0	9.8	—	

*Boron and manganese sampled less than four years

formed primarily at the Data Analytical Laboratorium in Lyngby.

Results

The Individual Nutrients

Nitrogen

Variation of nitrogen in the leaf dry matter was quite large for pears, ranging from 1.63 % to 3.36 %. For the full period, the average content was 2.49 % (Table 3). The average nitrogen content of cherries was notably higher (3.13 %) with a range of 2.16 % to 4.39 %. The nitrogen content in plums is quite close to that of pears with an average of 2.58 % and a range of 1.66 to 3.28 %.

The distribution of the collected samples at different intervals is shown in figure 1 a. The pear samples had 7 % below, 75.5 % at and 17.5% above the tentative optimal level. Cherry samples were similar with 5.3 % below, 79 % at, and 15.7 % above the tentative optimal level. The plum samples had 35.5 % below, 50 % at, and 11.5 % above the tentative optimal level.

To understand the yearly variation at the single location, the samples are shown at intervals in relation to the average of the four sampling years. This is shown in figure 2 a for all localities. Pears had 77.1 %, cherries 55.9 %, and plums 61.7 % of their sampling within the interval of $\pm$ 0.2 of the average. The early variation is somewhat smaller for pears than for cherries and plum.

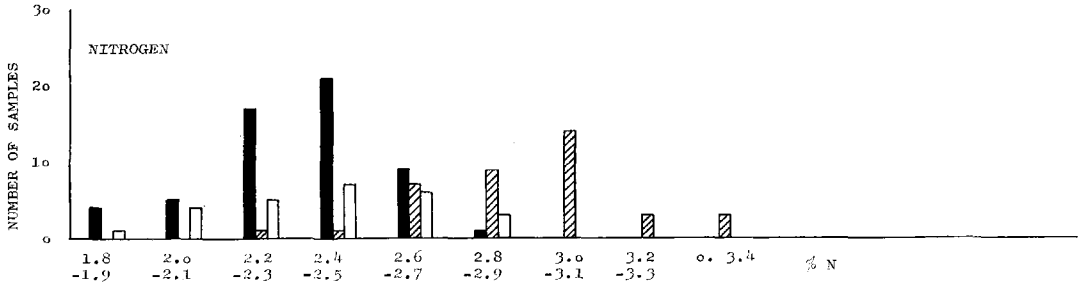


FIG 1.a

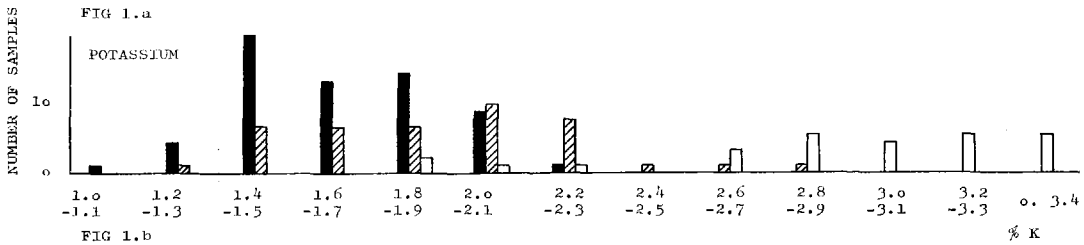


FIG 1.b

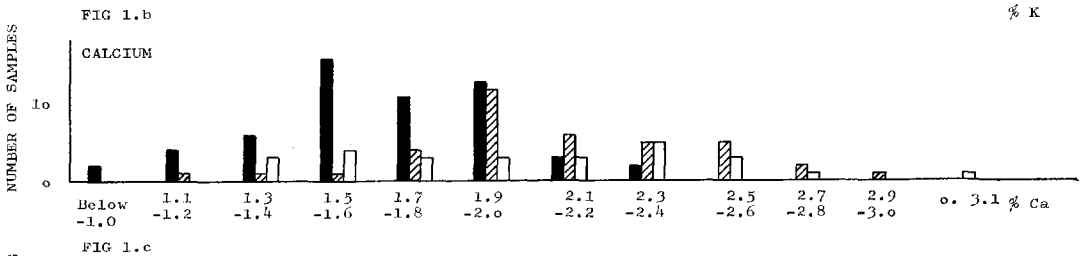


FIG 1.c

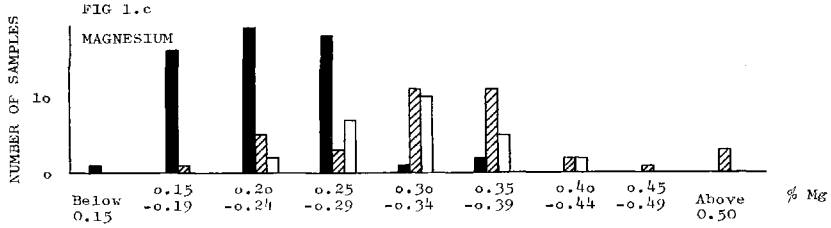


FIG 1.d

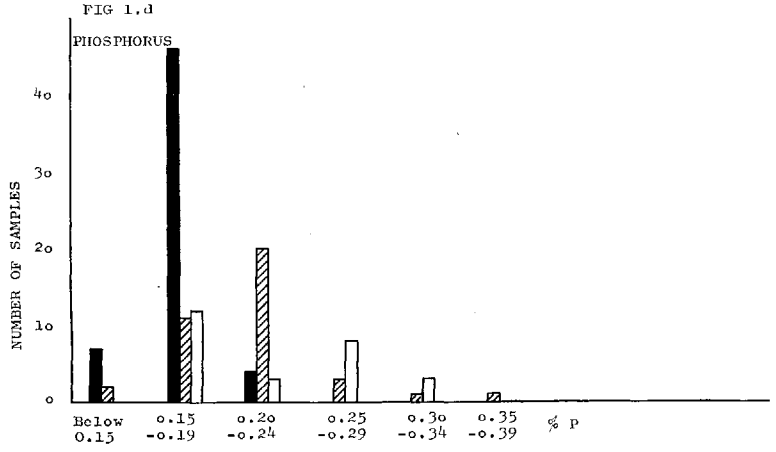
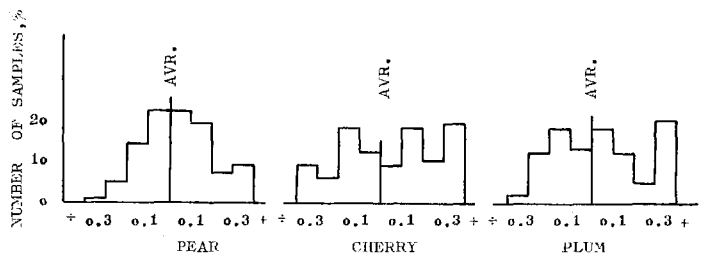
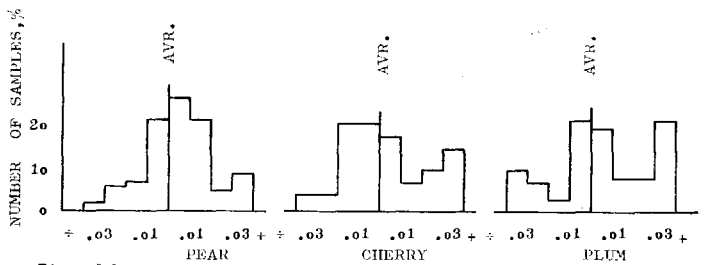


FIG 1.e

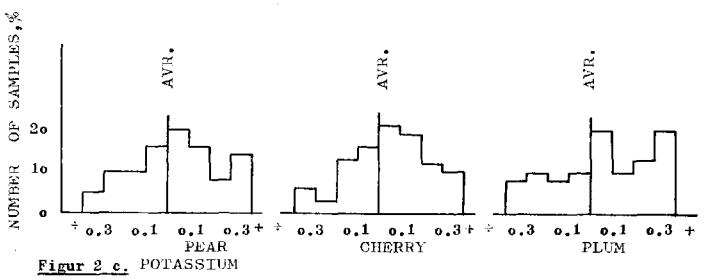
Figur 1 a-e. Leafsamples distribution according to nutrient content ■ Pear ▨ Cherry □ Plum Avr. 1967-7o



Figur 2 a. NITROGEN

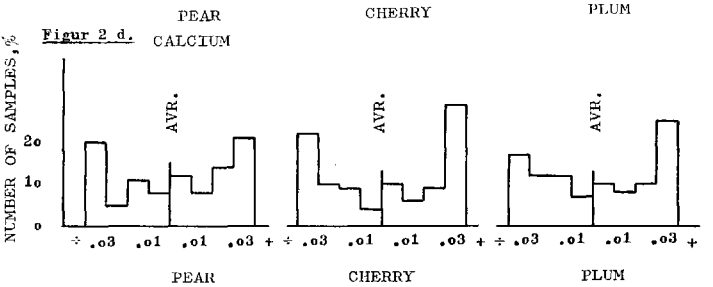


Figur 2 b. PHOSPHORUS



Figur 2 c. POTASSIUM

Figur 2 d. CALCIUM



Figur 2 e. MAGNESIUM

Fig. 2a-e. Destribution of the single years leafsamples in relation to the average 1967-70 for the simgle location.

Phosphorus

Variation in the pear samples ranged from 0.11 to 0.31 percent with a four year average of 0.18 % and with insignificant yearly variations. Cherry samples ranged from 0.13 to 0.41 percent P with a four year average of 0.22 %. Cherries also show very little yearly variation of average P content. Plums had the highest four year average with 0.25 %. The range was from 0.13 % to 0.46 %. The leaves of cherry and plum have a higher phosphorus content and greater variation than those of pear. The distribution of the samples in relation to the optimal levels is good, since pears show 10.3 % below and 87.7 % at the optimal level, cherries 34.2 % below with 65.8 % at the optimal level and plums 46.1 % below with 53.9 % at the optimal level (fig. 1 e).

Variation at a single location in relation to the four year average was rather large, since for pears only 68.8 %, for cherries 66.2 %, and for plums 53.3 % of the samples were within the average $\pm$ 0.2 (fig. 2 b).

Potassium

Pears:

Potassium content ranged from 0.75 % to 2.45 % with an average of 1.65 % with slight variation from the average in any single year, except 1970 where the deviation is high as it was for nitrogen (Table 3). 18 % of the samples were below, 38.6 % at, and 59.6 % above the optimal level (fig. 1 b). At a single location the average $\pm$ 0.2 contained 62.9 % of the samples (fig. 2 b).

Cherries:

Cherries had a larger variation in potassium content than pears, ranging from 0.95 % to 3.67 %, and a higher four year average of 1.98 % K. Just as for pears, the 1970 average is lower than the other three years. 18.4 % below, 31.5 % at, and 50.1 % above the optimal level (fig. 1 b), a distribution partly similar to that found in pears. At the single location the variation is quite large with only 69.1 % of the samples within $\pm$ 0.2 of the average (fig. 2 c).

Plums:

Plum leaves had the highest potassium content. The range was from 1.61 % to 5.44 % with a four year average of 2.92 %. In relation to pears and cherries, the entire sample was at a higher level. The plum sample had a much larger percentage above the optimal level. The higher potassium level brings about greater variation from year to year and at the single location only 48.3 % of the samples were found within $\pm$ 0.2 of the average.

Calcium

Cherries and plums had a slightly higher calcium level than pears. The range of calcium content in pears was from 0.86 % to 3.01 % and in cherries and plums from 0.95 % to 3.46 and 0.94 % to 3.18 % respectively. For pears the four year average was 1.76 %, for cherries 2.10 % and for plums 2.15 % (Table 3). The optimal levels for pears, plums and cherries are identical, 1.20 % to 2.00 % Ca. Pear samples had 10.5 % below, 80.7 % at, and 8.8 % above this level. Cherries had 2.6 % below, 47.4 % at, and 50.0 % above the optimal level. Plum had 50 % at and 50 % above the optimal level. At the single location, the average $\pm$ 0.2 contained 62.1 % of the samples for pears, 51.5 % for cherries and 63.3 % for plums (fig. 2 d).

Magnesium

Magnesium was found similar to calcium. The cherries and plums had a higher level than pears as seen by the variation of pears from 0,11 % to 0.43 %, of cherries from 0.18 % to 0.67 %, and of plums from 0.19 % to 0.48 % Mg. For the four period the average were 0.25 % for pears, 0.36 % for cherries and 0.34 % for plums (Table 3). Pear samples had 29.8 % below, 64.9 % at, and 5.3 % above the optimal level, cherries had 2.6 % below, 21.1 % at, and 76.3 % above the optimal level, and plums had 34.6 % at,

Table 4

		r	sign.
Pear			
% N – % Mg	y = 2.12 + 0.12 x	0.25	***
% N – % Ca	y = 2.09 + 0.20 x	0.28	***
% N – % P	y = 1.72 + 0.40 x	0.34	***
% K – % Mg	y = 2.18 ÷ 0.20 x	÷0.37	***
% K – % Ca	y = 2.23 ÷ 0.32 x	÷0.41	***
% Mg – % Ca	y = 0.10 + 0.83 x	0.58	***
Cherry			
% N – % K	y = 2.48 + 0.28 x	0.31	***
% N – % P	y = 2.48 + 0.26 x	0.33	***
% K – % Mg	y = 2.87 ÷ 0.26 x	÷0.65	***
% K – % Ca	y = 2.99 ÷ 0.50 x	÷0.56	***
% Mg – % Ca	y = 0.08 + 1.65 x	0.74	***
% Mg – % P	y = 0.23 + 0.54 x	0.25	***
Plum			
% N – % Ca	y = 2.10 + 0.20 x	0.27	**
% K – % Mg	y = 4.12 ÷ 0.33 x	÷0,29	**
% Mg – % Ca	y = 0.26 + 0.34 x	0.29	***

and 65.4 % above the optimal level. The distribution is as for calcium in agreement with the various levels found for the three species (fig. 1 d). At the single location the average ± 0.2 contained 39.3 % of the pear samples, 29.4 % for cherries, and 36.6 % for plums (fig. 1 e). This great year to year variation must evaluated in light of the widespread practice of spraying with magnesium.

Boron and manganese

A portion of each years leaf samples was analysed for boron while they were analysed for manganese only in 1969. Boron content ranged from 15 to 42 ppm in pears, 23 to 91 ppm in cherries, and 21 to 42 ppm in plums with the four year averages being 23 ppm for pears, 43 ppm for cherries, and 31 ppm for plums.

Manganese content ranged from 16 to 107 ppm in pears, 23 to 91 ppm in cherries and 14 to 91 ppm in plums with the average being about 40 ppm for all three fruits (Table 3).

Interaction

Nutrients Mutual Relationship

The interaction of the nutrients is shown in Table 4. A significant correlation is present in several cases, but a meaningful covariation can only be proven for magnesium-calcium for pears and for potassium-calcium and magnesium-calcium in cherries where the correlation coefficients are over 0.5. In all cases, however, the correlation coefficients are low.

Table 5

	Leaf analysis, Percent of Dry Matter				
	N	P	K	Ca	Mg
Clara Frijs pears.	2.37	0.17	1.82	1.28	0.20
Conference pears	2.50	0.18	1.50	1.92	0.27
Opal plums	2.35	0.21	3.75	1.63	0.31
Other plums	2.54	0.23	2.88	2.11	0.33

Cultivar Variations

It is possible to separate the pear and plum samples by cultivars, and in both fruits a variety difference can be seen (Table 5). Clara Frijs pears had a significantly lower calcium and magnesium content but a higher potassium content than Conference. Similarly, Opal plums had significantly lower calcium and magnesium content but a higher calcium content than other plums.

Soil Type

In Table 6 a distribution of materials is shown for various soil types characterized by clay content (estimated as light, medium, and heavy soils). As the clay content increases, the potassium content decreases, while the content of phosphorus, magnesium and calcium increases. The leafs nitrogen content is unaffected by soil type.

Since a covariation has been found between potassium-calcium and potassium-magnesium, it is easy to suppose that this relation affects and that the observed variation especially is caused by variation in potassium content with soil type.

Yield Level

When the leaf samples were collected, the yield level was estimated in relation to nor-

Table 6

Leaf analysis, part of Dry Matter*

	Soil type	N	P	K	Ca	Mg
				%		
Pear	heavy.....	2.38	0.18[a]	1.59[a]	1.75[a]	0.24[a]
	medium.....	2.49	0.17[b]	1.72[b]	1.61[b]	0.24[a]
	light.....	2.34	0.16[b]	1.91[c]	1.46[b]	0.21[b]
Cherry	heavy.....	3.05	0.25[a]	1.89[a]	2.20[a]	0.38[a]
	medium.....	3.03	0.21[b]	1.97[a]	2.05[ab]	0.35[a]
	light.....	3.00	0.20[b]	2.02[a]	1.96[b]	0.31[b]
Plum	heavy.....	2.49	0.24[a]	3.09[ab]	2.06[a]	0.33[a]
	medium.....	2.52	0.22[a]	2.88[a]	2.08[a]	0.32[a]
	light.....	2.28	0.18[b]	3.76[b]	1.35[b]	0.28[a]

*No sign. between numbers with same letter figure.

Table 7

Leaf analysis, Percent of Dry Matter*

	Yield levels	N	P	K	Ca	Mg
Pear	low.....	2.28[a]	0.17	1.83[a]	1.54[a]	0.23[a]
	medium.....	2.38[a]	0.17	1.71[b]	1.61[a]	0.23[a]
	high.....	2.54[b]	0.18	1.49[c]	1.82[b]	0.26[b]
Cherry	low.....	2.88[a]	0.23	2.06[a]	1.88[a]	0.32[a]
	medium.....	3.07[b]	0.21	1.98[a]	2.02[a]	0.34[a]
	high.....	3.10[b]	0.22	1.81[b]	2.28[a]	0.39[b]
Plum	low.....	2.39[a]	0.22	2.98	1.84[a]	0.29[a]
	medium.....	2.45[ab]	0.24	2.90	1.79[a]	0.30[a]
	high.....	2.57[b]	0.22	2.94	2.28[b]	0.35[b]

*No sign. between numbers with same letter figure

mal levels for those trees. The analysis showed an increase in nitrogen, calcium and magnesium and a potassium decrease with rising yield, while the leafs phosphorus content remains unaffected (Table 7).

Discussion

A preceeding analysis of the nutritional state of danish apple orchards showed a high level of nitrogen and potassium content in many samplings *(Vang-Petersen et al.* 1973). Because pears, cherries and plums presumably are fertilized by the same criteria as apples, similar results could be expected. A large number of samples were, in fact, found to have potassium content above the optimal level, while nitrogen content in a large number of samples was within that level. At the time when this project was started, a recommendation for practice, based on findings in the above mentioned investigation of apple orchards, had already begun. It must be assumed it is the results of this recommendation, which can be detected in pears, cherries and plums.

The magnesium content of pears is slightly lower than desired, supposedly as a result of high potassium content though the deficiency is not as marked as found earlier in apples.

A contributing factor to this could be spraying with magnesium sulfate which is a fully accepted cultivation practice in danish orchards today. Both cherries and plums show a relatively large number of samples with a magnesium content above the optimal level.

The same relationship exists for calcium and there is some indication that the temporary optimal levels for these nutrients were set too low. Phosphorus in pears is within the optimal level while cherries and plums often are below that level. Since earlier danish research *(Sandvad,* 1962) found no results due to phosphoric acid fertilization of cherries and plums, it must be supposed that these optimal levels were too high.

In 1970 the pears and cherries deviate from the other years, the leaf content of N, Ca, and Mg is higher and of K lower than in the other years. It has been found *(Archibald* 1964) that low precipitation can cause low potassium content, and especially in 1970 the months of May, June and part of August were unusually dry. At a single location there is indication of a rather large year to year variation. This situation must be caused by variation in the yield *(Hansen* 1965, *Hansen* 1971) and climatic influences on the soils fixation of nutrients as well as the soils nitrate producing ability *(Poulsen* and *Hansen* 1962).

The covariation between the nutrients which has been shown is not very firm in relation to what can be found in specific fertilizing research. Nutrients influence on each other is not very clear because of differently fertilized trees involved and because use of nutrient-containing fungicides and nutrient sprays with magnesium and calcium is quite common. Potassium is negatively correlated with both magnesium and calcium and this explains why calcium and magnesium are positively and quite steadily correlated, both being dominated by the potassium level. Differences among various cultivars of apples were found earlier *(Hansen* 1971, *Vang-Petersen et al.* 1973). *Archibald* (1964) among others found differences among various cultivars of pears.

The effect of yield level on the nutrient content of leaves was shown for apples *(Hansen* 1971) and the results are similar to those of this report. Also the variation of leaves nutrient content with soiltype is similar to that of apples *(Vang-Petersen et al.* 1972). When a higher potassium content is found in light soil than in heavy soil it is most likely due to greater penetration of potassium fertilizer in the light soil. *(Poulsen* and *Dalbro* 1963) and that a stronger fixation occurs in the heavier soil types.

Conclusion

The results of this study of danish pear, cherry and plum orchards show, that the level of the individual nutrients in the leaves correspond to results of earlier research. The temporary optimal levels based mainly on foreign experience were shown not to be in complete agreement with the actual danish conditions. On the basis of the collected materiel the following levels are proposed (table 8).

Evaluated on the basis of these optimal levels, the nutritional state can be described as quite satisfying although the trees are oversupplied with potassium.

At the single location the nutrient content of the leaves varies from year to year possibly

Table 8

Leaf analysis part of Dry Matter

Optimal values	%					ppm	
	N	P	K	Ca	Mg	B	Mn
Pear	2.0–2.5	0.15–0.30	1.2–1.6	1.2–1.8	0.20–0.30	20–50	30–150
Cherry	2.6–3.2	0.15–0.30	1.4–1.9	1.6–2.1	0.25–0.40	20–50	30–150
Plum	2.3–2.8	0.15–0.30	2.2–2.8	1.6–2.1	0.25–0.40	20–50	30–150

due to climate and soil variations. Because of this the single sample can represent the average only to a limited extent. When interpreting the results of the analysis, consideration must be given to the fact that potassium influences magnesium and calcium and that there are also an affect by the yield level and soil type and finally that cultivar differences are involved.

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Resumé

I årene 1967-70 er der indsamlet bladprøver i danske pære-, kirsebær- og blommeplantager til analysering for N, P, K, Ca, Mg, B og Mn. Ernæringstilstanden er fundet tilfredsstillende bortset fra kalium, hvor der er tale om overforsyning. Der er god overensstemmelse med, hvad der tidligere er fundet i andre lande. Det foreliggende materiale har givet mulighed for at udarbejde optimalværdier for bladanalyser i de tre arter, tilpasset danske forhold. Ved tolkning af bladanalysen må der tages hensyn til aktuelt udbytteniveau, jordtype og sortsforskelle samt til antagonistiske forhold mellem specielt kalium- og magnesium-calcium.

Litteratur

1 *Archibald, J. A.* (1964). Weather effects on leaf-nutrient composition of fruit crops. Plant Analysis and Fertilizer Problems. IV (1964). 1-8. W. F. Humphrey Press, Inc., Geneva, New York.

2 – *and R. A. Cline* (1962). Factors affecting leaf-nutrient composition of Montmorency cherry. Report of the Hort. Exp. Sta. and Products Lab. Vinelad, 39-41.

3 *Beyers, E.* (1962). Diagnostic leaf analysis for deciduous fruit. South African Journal of Agricultural Science 5, 315-29.

4 *Briant, A. and Trocmé, S.* (1964). Observations sur la composition minerale de feuilles d'arbres fruitiers en fin de vegetation. Plant Analysis and Fertilizer Problems Vol. 4, 79-89.

5 *Fritzsche, R., B. Krapf* und *L. Huber* (1964). Düngungsversuche mit Apfel- und Kirschbäumen in Gefässen. Schweizerische Landwirtschaftliche Forschung 3, 121-181.

6 *Hansen, P.* (1965). Æbleblades næringsstofindhold II. Afhængighed af grundstamme, sort, år, bæring og nedbør. Tidsskr. f. Planteavl 69: 305-313.

7 – (1971). The effects of cropping on uptake, content, and Distribution of Nutrients in apple Trees. Tidsskr. f. Planteavl 75: 615-25.

8 – (1971). Bladanalyser i danske pære-, kirsebær- og blommeplantager. Nordisk Jordbrugsforskning (1971) 53-66.

9 *Hewitt, A. A.* (1967). The effects of nitrogen fertilization on some fruit characteristics in 'Bartlett' pear. Proc. Amer. Soc. Hort. Sci. 91, 90-95.

10 *Kenworthy, A. L.* (1950). Nutrient-element composition of leaves from fruit trees. Proc. Amer. Soc. Hort. Sci. 55, 41-46.

11 – (1953). Nutritional condition of Michigan orchards: A survey of soil analyses and leaf composition. Technical Bulletin 237, June 1953, Michigan State College Agricultural Experiment Station. East Lansing.

12 *Kwong, S. S.* (1964). Potassium fertilization in relation to titratable acids of sweet cherries. Proc. Amer. Soc. Hort. Sci. 86, 115-119.

13 Langenbruch, Gustav-Adolf. (1970). Der Ernährungszustand von Birnbäumen und die Beinflussung des Bodennährstafgehaltes bei Einheitlicher Mineral Düngung auf bisher langjährige Unterschriedlich versorgten Fläschen Dissertation.

14 *Lilleland, O.* and *J. G. Brown.* (1938). The Potassium nutrition of fruit trees II. Leaf analyses Proc. Amer. Soc. Hort. Sci. 36, 91-98.

15 *Ljones, Bjarne* (1966). Ranges of the nutrient status of fruit trees and small fruits as evaluated by leaf analyses and yield records. Meld. Norges Landbr. Högsk. 45, 12.

16 *Måge, Finn* (1968). Næringstilstanden i kirsebærhagar i Hardanger. Meld. Norges Landbr. Högsk. 47, 17.

17 *Poulsen, E. & S. Dalbro* (1963). Forskellige jordtypers gennemtrængelighed for kalium og magnesium. Tidsskr. f. Planteavl 66: 50-74.

18 *Poulsen, E. & P. Hansen* (1962). Undersøgelser over jordens nitratindhold. Tidsskr. f. Planteavl. 65: 206-234.
19 *Proebsting, E. L.* (1952). Certain factors affecting the concentration of N, P, K, Ca and Mg in pear leaves. Proc. Amer. Soc. Hort. Sci. 61, 27-30.
20 *Proebsting, E. L.* and *J. G. Brown* (1954). Leaf analysis of differentially covercropped deciduous fruit trees. Hilgardia 23, 125-153.
21 *Proebsting, E. L.* (1961). Response of Bartlett pear to nitrogen in California. Calif. Agricult. nr. 6, p. 14-15.
22 *Sandvad, K.* (1963). Gødningsforsøg med kirsebær og blommer. Tidsskr. f. Planteavl. 66: 609-642.
23 *Smith, C. B.* (1965). A five-year nutritional survey of Pennsylvania apple, peach and sour cherry orchards. Bull. Pennsylv. Agr. Exp. Sta. no. 717, 1-16.
24 *Vang-Petersen, O., E. Poulsen & P. Hansen* (1973). Ernæringstilstand i danske frugtplantager belyst ved bladanalyser. I. Æbler 1963-66. Tidsskr. f. Planteavl 77: 37-47.
25 *White, G. C.* (1967). The response of Merton Heart cherries to nitrogenous fertilizers. Rep. E. Malling Res. Sta. for 1967 (1968). p. 129-33.

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