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Fertilizing sour cherry (*Prunus cerasus* L. cv. Stevnsbær) with N, P, and K

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1. Summary

The effects of nutrition with N, P, and K and of different soil-pH on growth and yield of sour cherry (*Prunus cerasus* L. cv. 'Stevnsbär') were investigated in a field experiment during 12 years. Nitrogen and potassium influenced growth and increased yield, while phosphorus gave no effects at all. Fruit size decreased with nitrogen and increased with potassium application. Low level of soil pH decreased yield but gave no effects on fruit size. Interpretation of content of nutrients in leaf d.m. with use of boundary lines indicated 2,8% N, 0,2% P, and 1,4% K as the lower limits of optimum ranges for these nutrients.

Key words: *Sour Cherries, Nutrition, Leaf Analysis, Soil-ph*

2. Introduction

Fruits from clones of the cherry species *Prunus cerasus* L. used for wine production represents 70–80% of the total commercial cherry production in Denmark. The clone used is named 'Stevnsbär' (*Christensen* 1976) and seems quite similar to 'Westerlees Kriek', grown in Holland (*Christensen* 1966).

In earlier research with 'English Morello', *Sandvad* (1963) found no effect of nitrogen application, no effect of phosphorus application and some effect of potassium application in field experiments. *Lenz* and *Bünemann* (1974) found in the similar cv. 'Schattenmorelle' some effect of nitrogen application and no effect of potassium application in field experiments too. *Vang-Petersen* (1975) stated that according to nitrogen 'Stevnsbär' needs more than do 'English Morello', and required a higher N-level in leaf d.m. to reach optimum level too. About pH-level in the soil *Sandvad* (1963) found a low level (pH = 6.5) beneficial for the 'English Morello'both for tree growth and yield.

3. Materials and methods

In an area with 35 years old, unfertilized and therefore nutritional stable, plots, trees of sour cherry, cultivar 'Stevnsbär', were planted in an experimental design with four levels of nitrogen, three levels of phosphorus, and three levels of potash. In addition there were two levels of soil-pH.

Sour cherry (*Prunus cerasus* L. cv. 'Stevnsbär') grafted on *Prunus Avium* were planted as two years old trees and spaced on 7.0 × 1.75 m. There were three trees in each plot (7 × 7 m), the central tree used for the experiment, and six replicates. After five seasons of growth every second tree were grubbed and the final spacing was then 7.0 × 3.5 m. Soil cultivation was clean soil + cover crop.

Leaf samples were picked, analysed and interpreted as described by *Vang-Petersen* and *P. Hansen* (1973). In soil analysis pH was measured in H_2O, phosphorus by spectrofotometry after extraction for two hours in 0.2 n H_2SO_4 and potash by flame fotometry after extraction for several hours in 0.5 n CH_3 COO NH_4.

4. Results

Yield from max. N, P, K-fertilized trees is shown in Figure 1 for the experimental period and main results from the different treatments are tabulated in Table 1.

Experimental design was as follows:

	season of growth*) 1 – 7	8 – 12	fertilizer used
N o	Control	Control	
N 1	62 kg N ha^{-1}	54 kg N ha^{-1}	
N 2	124 kg »	108 kg »	$Ca(NO_3)_2$
N 3	124 kg »	162 kg »	
P 0	Control	Control	$Ca(H_2PO_4)_2$
P 1	24,4 P ha^{-1}	31,2 kg P ha^{-1}	+ $CaSO_4$
P 2	46,8 kg »	62,4 kg »	
K 0	Control	Control	
K 1	147 kg K ha^{-1}	49 kg K ha^{-1}	KC1
K 2	147 kg »	98 kg »	
K 3	147 kg »	147 kg »	
pH 1	pH level low	pH level low	
pH 2	pH level medium	pH level medium	

*) First season of growth is defined as the first summer after planting.

4.1 Nitrogen

Content of nitrogen in the leaves is increased for N 1 and N 2, but not further for N 3. Application of nitrogen has increased tree growth assessed by weight of trees grubbed after five years of growth. At the end of the experiment there was no significant difference in tree size as assessed by trunk circumference. Growth rate of the trunks in the 8th–12th seasons of growth has decreased with increased nitrogen. Nitrogen application has increased the yield and decreased the fruit size.

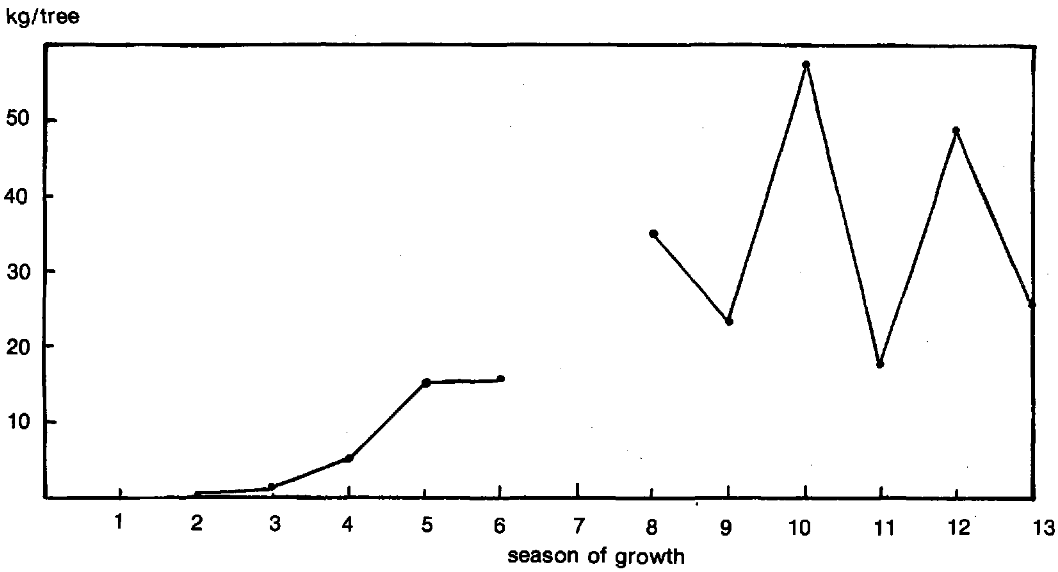

Fig. 1. Average yield of trees during the experimental period. Trees fertilized with 124 kg N, 23 kg P, and 147 kg K per hektare.

Tabel 1. Results of the soil- and leaf analysis, tree growth, yield, and fruit size

	Soil analysis at the end of the trial, 0–20 cm, mg/100 g soil			Soil analysis at the end of the trial, 20–40 cm, mg/100 g soil			Leaf analysis % of dry matter av. 3–13 season			Weight of trees, grubbed after 5th season of growth[1]), kg	Trunk circumference, cm after 8 seasons of growth	Trunk circumference, cm end of experiment	Yield, kg tree^{-1} 2nd–6th season of growth	Yield, kg tree^{-1} 8th–13th season of growth	Fruit size, g 100 berries^{-1} 2nd–7th season of growth	Fruit size, g 100 berries^{-1} 8th–13th season of growth
N o							2.38	0.32	2.04	4.7	33.1	45.4	4.8	25.7	291	328
N 1							2.65			9.6	40.6	50.8	10.9	32.1	290	324
N 2	6.0	56	32	6.3	45	18	2.75	0.19	1.90	11.2	38.8	47.0	12.2	34.4	306	318
N 3							2.77			9.9	42.8	51.5	–	37.5	–	315
Sign.										***	**	n.s.	*	**	n.s.	**
LSD95										1.9	4.8	–	4.3	4.6	–	6
P 0		42			37			0.18		9.3	38.1	47.5	6.8	30.6	291	307
P 1	6.0	56	29	6.3	43	14	2.67	0.20	1.68	9.8	42.4	51.0	10.6	33.6	297	315
P 2		57			40			0.18		8.1	38.4	48.1	8.4	32.3	283	315
Sign.		***		n.s.					n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	
LSD95		3			–					–	–	–	2.4	–	–	–
K 0			12			8			0.61	8.0	33.8	42.1	2.9	19.7	264	279
K 1			21			11			1.40	9.7	38.3	46.7	8.2	27.4	282	314
K 2	6.0	52	26	6.4	43	13	2.64	0.19	1.60	8.1	40.4	48.9	–	31.3	–	332
K 3			34			21			1.93	–	42.8	51.5	–	37.5	–	315
Sign.			***			***				n.s.	*	n.s.	†	***	†	***
LSD95			2			2				–	5.1	–	–	5.3	–	9
Ph 1	5.6	53	30	5.7	43	16	2.76	0.16	1.76	8.7	39.2	48.3	7.9	26.5	291	314
Ph 2	6.0			6.3						11.2	38.9	47.1	12.3	34.4	306	318
Sign.	***			***						*	n.s.	n.s.	†	**	n.s.	n.s.
LSD95	0.1			0.2						2.10	–	–	–	2.5	–	–

*** P (99,9), ** P (99), * P (95), † (90)

[1]) First season of growth is defined as the first summer after planting.

4.2 Phosphorus

Application of phosphorus has only changed P-content in the surface layer 0–20 cm and not at all changed P-content in the leaves. The only response from the trees is an increase in yield in the first period of the experiment.

4.3 Potassium

K-content in soil, both depths, and in leaves was increased for each step of application. Tree size was not increased significantly for the total period, but there is a tendency for bigger trees after K-application. Yield is increased and so is the fruit size.

4.4 Soil pH-level

Low soil pH level, established in both depths, had reduced tree growth assessed by weight of the grubbed trees after five years of growth. Trunk growth, measured by trunk circumference shows no difference in tree size at the end of the experiment. The yield was highest at the highest pH-level, and there was no effect on fruit size.

4.5 Leaf analysis

Relation between leaf nitrogen, yield and application of nitrogen is shown in Figure 2. The first amount (54 kg N ha^{-1}) rised % N in the leaves 0.2% and the yield about 15%. The next applica-

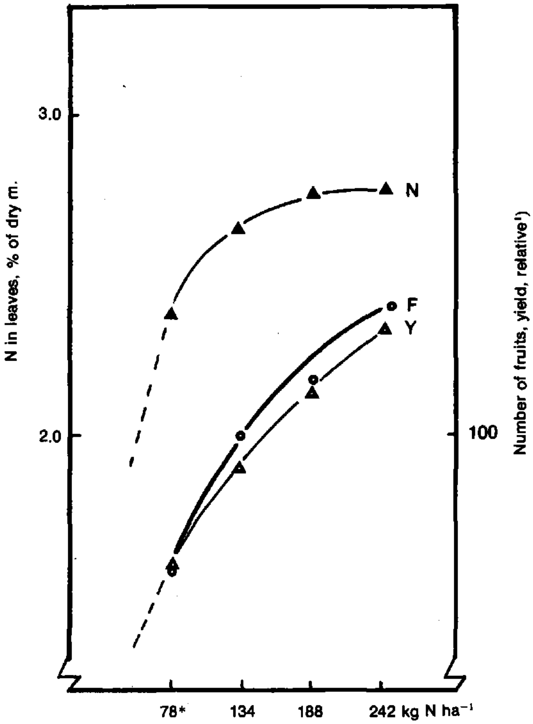

Fig. 2. Increase in N-content in the leaves and in yield and numbers of fruits for nitrogen application. [1]) Relative, 100 = average of all treatments. *) Average soil produced N according to Dalbro and Nielsen (1959) is used as zero level. N = % N, F = fruits, Y = yield.

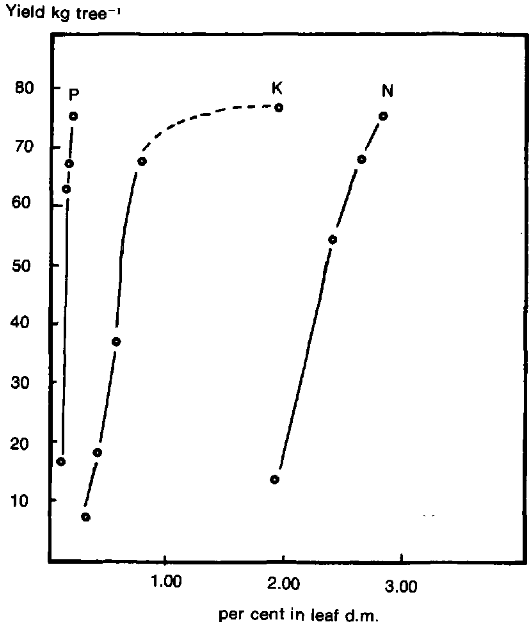

Fig. 3. Boundary lines for correlation between leaf nutrient content and yield. Based on 100–120 leaf analysis during 5 years for each nutrient.

tion of 54 kg N ha^{-1} rised % N further with 0.17% and yield about 12%. The last amount of 54 kg N ha^{-1} gave no response in leaf nitrogen content but surprisingly there was a yield response of about 10%. Making a correction of this yield on the basis of tree size indicates that bigger trees in this case is the explanation.

Plotting leaf content of nitrogen, phosphorus and potassium and the corresponding yield in a diagram shows no meaningful correlation, because other things than nutrition often are the limiting factors on yield. Instead the boundary lines (Webb, 1972) are established as shown in Figure 3. These seem in good accordance with the optimal ranges, used for evaluation, except for nitrogen where the lower limit of 2.6% N is too low.

5. Discussion

The increase in tree weight for the first years with small amounts of fruits and then the lowered growth rate in the 8th–13th seasons of growth by increasing N-application indicates that tree growth as assessed by trunk growth has taken precedence for fruit yield. Fertilized trees reach full trunk size earlier than do deficient trees.

The increase in yield by increasing N-application is in agreement with the findings of *Vang-Petersen* (1975) and to some extend of *Lentz* and *Bünemann* (1974) but contrary to that of *Sandvad* (1963). The diverge between the latter is presumably due to different soil cultivation/cover crop and N-production in the soils and therefore a difference in the basic N-supply. In this investigation there is no such differences to the work of *Sandvad* (1963) and it is concluded that 'Stevnsbär' can utilize more nitrogen than do 'English Morello'.

The apparent lack of connection between leaf N-content and yield for the last amount of nitrogen is also found earlier by *Vang-Petersen* (1975) and the only reasonably explanation seems to be that it is an effect of improved tree size, not shown in trunk circumference (higher trees), and as a consequence yields a larger number of fruits per tree (figure 2).

In the experimental period the soil has been supplied in total with 640 kg P ha^{-1} (P 2) without response in leaf P-content and only a yield response in the first years of experiment. It seems obvious that the trees require less phosphorus, than the natural amount, given by this soil itself.

Potassium has increased tree size, but not significantly. Yield is increased but again there is not the expected correlation between leaf nutrient content and yield. As for nitrogen it can be explained by the different tree sizes. The findings are in agreement with *Sandvad* (1963) but not with *Lentz* and *Bünemann* (1974), the latter diverge presumably due to higher K-levels in the soil in the German experiment.

The positive effects of soil pH at 6.5 caused by bigger trees as found by *Sandvad* (1963) are in agreement with the findings in this experiment.

The values of P and K in leaf d.m. are in good accordance to the optimal values, found in earlier research *(Vang-Petersen* and *P. Hansen* 1973) while optimum range of nitrogen in agreement with *Vang-Petersen* (1975) has to be increased in comparison with 'English Morello'. The use of boundary lines *(Webb* 1972) confirms the lower limits of optimum ranges of 2.8–2.9% N, 0.20% P, and 1.40% K in leaf d.m. The lack of correlation between leaf nutrient content and yield is due to the fact that potential yield for a given content of nutrient is not always reached because other conditions are the limitting factors.

Resumé

Hos 'Stevnsbær' er virkning af gødskning med kvælstof, fosfor og kalium undersøgt gennem 12 år i et markforsøg. Samtidig er virkning af forskelligt pH-niveau undesøgt. Kvælstof og kalium påvirkede væksten og øgede udbyttet, medens der ikke var virkning af fosfortilførsel. Kvælstof reducerede og kalium øgede frugtstørrelsen. Lavt pH-niveau reducerede udbyttet uden at påvirke frugtstørrelsen. Tolkning af bladanalyser ved brug af randkurver viste 2,8% N, 0,2% P og 1,4% K som nedre grænser for de pågældende optimalområder.

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