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# Evaluation of Clones of the Apple Cultivar 'Discovery' in Denmark

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## Abstract

Clones of the apple cultivar 'Discovery' were evaluated. In the first experiment eighteen clones were planted in 1986. Six were chosen because of a good fruit appearance in combination with high yield and big fruits. The clones Glim, H 4108 (the standard), LA 73 A, II A 1366, II A 1327 and Nykoebing S were planted in 1992 in the second experiment. None of the newer clones was found to be superior in all respects but LA 73A seems interesting because of a high total yield and Nykoebing S produced a high yield of well-colored fruits.

## Introduction

The apple cultivar 'Discovery' was selected in England in about 1949 and it was named in 1962 (8). The cultivar was introduced to the Danish growers in 1972 and has been constantly on the list of cultivars recommended for planting ever since (5). Today 'Discovery' is the only early ripening cultivar recommended for planting in Denmark (6). 'Discovery' comprises 9% of the apple trees found in commercial orchards in Denmark in 1997 (4).

'Discovery' apples have a greenish yellow ground color and flushed with bright red (8). First Class requirements for 'Discovery' fruits are a fruit size of minimum 60 mm and at least 33% red colored surface. Consequently a major criterion in selection of new clones is their higher red coloration. Fruit color is an important characteristic for many cultivars. It has been demonstrated for 'Delicious,' a cultivar with more than 100 strains (3) that color influences consumer acceptance (2).

The purpose of this study is to compare new clones and to determine if a better clone could be found for the future standard clone of 'Discovery' in Denmark.

## Materials and Methods

Eighteen clones were planted in autumn 1986. Fourteen clones originated from Danish localities and 4 clones came from the National Fruit Trials in England, Table 1. Different Danish growers selected the Danish clones included in this experiment at their orchards as natural occurring mutations. The clone 'H 4108' is the Danish standard clone and the only clone available for the growers at the nurseries. Included in the experiment were 4 English clones, originated from a breeding program carried out at the experimental station Long Ashton in the late 1970's. None of the clones are available in Denmark today.

Trees were planted as 2-year-old on M.26 with planting distance 4 m x 2 m. Two or three blocks of each clone were planted, each block consisted of 3 trees per clone. Fruit yield; fruit size and fruit appearance was recorded in 1989-91. The first screening process was done in 1991.

A new experiment was planted in autumn 1992 with clones selected from the screening in 1991. Clone selection was based on a high score for appearance in combination with high yield and large fruits. Clones selected: H 4108 (standard), LA 73A, II A 1366, II A 1327, Glim and Nykoebing S. Two-year-old trees on M.9 were planted at 3.75 m x 1.75 m. The experiment included 7 blocks with 3 trees of each clone per block. 'James Grieve' was used as pollinizer. Trees were grown with integrated pest and disease management and with fertilization according to leaf analysis.

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**Table 1. Summary of clone trial with 'Discovery' (planted in 1986).**

| Clone | Source | Country | Cumulative yield 1989-91 Kg/tree | Fruit size avg. 1989-91 g/fruit | Appearance avg. 1989-91 (1-9)[z] |
|---|---|---|---|---|---|
| 19-01 | H 4108 (standard) | DK | 30.6 | 116 | 4.7 |
| 19-02 | Glim | DK | 24.6 | 111 | 5.8 |
| 19-03 | Knuthenborg | DK | 26.2 | 116 | 5.2 |
| 19-04 | Nykoebing S | DK | 24.2 | 112 | 6.3 |
| 19-05 | II A 1306 | DK | 23.5 | 117 | 5.5 |
| 19-06 | II A 1323 | DK | 23.8 | 113 | 5.7 |
| 19-07 | II A 1327 | DK | 26.4 | 116 | 5.9 |
| 19-08 | II A 1329 | DK | 28.0 | 115 | 5.2 |
| 19-09 | II A 1353x | DK | 26.3 | 115 | 2.8 |
| 19-10 | II A 1358 | DK | 21.5 | 117 | 5.6 |
| 19-11 | II A 1363 | DK | 20.5 | 113 | 5.5 |
| 19-12 | II A 1365x | DK | 22.2 | 124 | 3.0 |
| 19-13 | II A 1366 | DK | 22.8 | 114 | 5.8 |
| 19-14 | II A 1370 | DK | 23.5 | 118 | 5.5 |
| 19-15 | Orig. tree 1 | UK | 31.2 | 115 | 3.9 |
| 19-16 | Orig. tree 2 | UK | 25.3 | 116 | 5.1 |
| 19-17 | LA 73A | UK | 32.4 | 112 | 5.8 |
| 19-18 | EMLA | UK | 22.6 | 122 | 5.7 |
| LSD | | | 2.2 | 4 | 0.7 |

[z]1 = very poor; 9 = excellent
Mean separation within columns by LSD at the 5 % level of significance.

Picking time was the same for the 6 clones. Fruits were picked by 2 times. Fruits from each tree were weighed annually and in 1997 and 1998 fruits were graded on a MAFF electronic grader. Class 1 comprises fruits of minimum 60 mm and minimum 33% red coloration. First class fruit was divided into 4 categories: A. Fruit size: 60-70 mm with 33-66% red coloration. B. Fruit size: 60-70 mm and >66% red surface color. C. Fruit size: >70 mm and 33-66% red surface color. D. fruit size: >70 mm and >66% red surface color.

It becomes interesting to compare the clones according to the yield of large and well-colored fruits. Only results of fruit size >60mm with > 66% red coloration of the surface (class B and D) are presented.

Fruit appearance was assessed visually after harvest by a trained panel of 6 persons. The panel was instructed to rate the fruit of each clone on a 1-9 scale, 1 = very poor appearance, 5 = medium appearance, 9 = excellent appearance. Included in the evaluations of appearance were scores for fruit shape, red coloration, russeting and uniformity of the harvested fruits. Evaluations were made in 1995, 1996 and 1998 on a representative sample of at least 50 fruits of each block.

**Table 2. Yield and cumulative yield (kg/tree) of 6 clones of 'Discovery' (planted in 1992).**

| Clone | 1995* | 1996* | 1997** | 1998** | 1995-98** |
|---|---|---|---|---|---|
| Glim | 2.6 d | 4.0 c | 6.3 c | 7.3 c | 20.6 d |
| H 4108 (standard) | 3.9 ab | 6.4 b | 10.1 a | 9.4 ab | 29.6 b |
| II A 1327 | 3.5 bc | 6.2 b | 7.4 bc | 9.9 ab | 27.0 b |
| II A 1366 | 3.2 cd | 6.2 b | 7.2 bc | 8.3 bc | 24.8 bc |
| LA 73A | 4.4 a | 7.9 a | 11.0 a | 10.7 a | 34.0 a |
| Nykoebing S | 3.5 bc | 6.6 b | 7.6 bc | 8.5 bc | 25.4 bc |

*Means within column (1995 and 1996) followed by the same letter do not differ at the 5% level of significance.
**Lsmeans within column (1997, 1998 and 1995-98) followed by the same letter do not differ at the 5% level of significance.

**Table 3. Fruit color development, percentage of class 1 fruits, and fruits > 60 mm and > 66% red surface.**

| Clone | Class 1 fruits, percentage of total yield | | Fruits >60 mm and >66% red surface kg/tree | |
|---|---|---|---|---|
| | 1997 | 1998 | 1997 | 1998 |
| Glim | 94.1 a* | 91.5 ab | 4.3 d | 4.1 b |
| H 4108 (standard) | 98.1 a | 91.6 ab | 7.3 ab | 5.2 ab |
| II A 1327 | 98.9 a | 92.1 ab | 5.8 c | 5.7 a |
| II A 1366 | 95.4 a | 90.9 b | 5.3 cd | 4.1 b |
| LA 73A | 97.8 a | 89.0 b | 7.3 ab | 4.9 ab |
| Nykoebing S | 98.9 a | 94.5 a | 6.1 bc | 5.7 a |

*LSmeans within columns followed by the same letter do not differ at the 5% level of significance.

Trees with severe fruit tree canker (caused by *Nectria galligena*) were removed in 1997 and 1998. The number of surviving trees was recorded in the autumn 1998.

Statistical analyses of data were performed using the analysis of variance SAS's General Linear Model (GLM) procedures to study the differences. Means of yield, fruit size and fruit appearance in balanced designs were separated with LSD ($p \leq 0.05$). In unbalanced designs least square means (Lsmeans) were computed and pairwise separated by t-test ($p \leq 0.05$). Unbalanced designs were a consequence of tree removal due to fruit tree canker.

## Results and Discussion

*Evaluation 1991.*

The primary criterion for the first clone selection was fruit appearance. Six of the clones planted in 1986 turned out to be attractive in combination with a high yield and large fruits (Table 1) and were selected for planting in a new experiment. H 4108 (the Danish standard clone) is characterized by a good growth and a high total yield. LA 73A, II A 1327, Glim, Nykoebing S and II A 1366 were selected because of good growth and a good production of attractive well-colored fruits. Nykoebing S in particular had fruits with a very attractive appearance.

*Evaluation 1998.*

*Cropping*

Among the selected clones planted in 1992 Glim was found to be unproductive, with a significant lower fruit yield each year than H 4108, the standard clone (Table 2). Cumulative yield revealed that II A 1366 and Nykoebing S were poor yielding clones too. LA 73A had the highest yield every year, but it was not significant different from H 4108. The highest total yield 1995-98 was found in LA 73A. LA 73A produced a cumulative yield 13% higher than H 4108.

*Fruit quality*

The fruits were graded for size and red coloration in 1997 and 1998. It is of course important that as many fruits as possible are first class. The total class 1 fruit comprised 97.2% of the total yield in 1997 and 91.6% in 1998 (results not shown). No differences in first class fruit between clones were found in 1997 (Table 3) but in 1998 Nykoebing S had a higher yield of class 1 fruits than II A 1366 and LA 73A. The yield of large well-colored fruits is an important trait in evaluating clones. An interaction between year and clone was found for yield of fruits >66 mm and with more than 66% red surface (Table 3). In

**Table 4. Fruit appearance evaluated in 3 years.**

| Clone | 1995 | 1996 | 1998 | average |
|---|---|---|---|---|
| Glim | 7.0[z] | 5.6 | 6.4 | 6.4 |
| H 4108 (standard) | 7.0 | 6.0 | 6.4 | 6.5 |
| II A 1327 | 7.6 | 6.9 | 6.6 | 7.0 |
| II A 1366 | 7.3 | 6.4 | 6.6 | 6.8 |
| LA 73A | 7.0 | 5.3 | 6.3 | 6.4 |
| Nykoebing S | 7.0 | 6.8 | 7.0 | 6.9 |
| LSD (0.05) | 0.4 | 0.6 | n.s.[y] | 0.3 |

[z]1 = Very poor, 9 = excellent.
[y]n.s. = not significant.
Mean separation within columns by LSD at the 5% level of significance.

1997 the yield of well-colored fruits was highest with H 4108, LA 73A and Nykoebing S. But In 1998 when significantly less fruits were class 1 fruits Glim and LA 73A had the smallest amount of fruits >66 mm and with more than 66% red surface. Glim and II A 1366 is of no interest due to a small production of well-colored fruits both years.

Fruit quality can be influenced by the choice of rootstock and planting density (1). The amount of class 1 fruit was found to be greatest with M.9 (1) the rootstock used in this experiment. Therefore no improvement in fruit coloration is expected to be obtainable by choosing another rootstock. On the other hand the planting distances are not optimized in this clone experiment (1), consequently a higher class 1 yield might be expected with a higher planting density.

*Fruit appearance*

Fruit appearance was visually evaluated 3 years (Table 4). The scores obtained were for all clones above medium (score 5) and although significant, only small differences in the visual evaluation were found between clones. This indicates that all clones had an attractive appearance. But the most attractive appearance was obtained by II A 1327, Nykoebing S and II A 1366 (Table 4).

*Tree survival*

Fruit tree canker *(Nectria galligena)* can be severe in 'Discovery' (7). At the end of the experiment 14% of Nykoebing S trees and 10% of Glim trees had been removed due to fruit tree canker. Since Glim in respect to productivity and fruit grade results is no improvement on H 4108 it cannot be recommended to be grown. Nykoebing S in contrast had an attractive appearance with many well-colored fruits. But since tree survival was poor it cannot be recommended as a possible alternative to H 4108.

## Conclusion

It is a difficult matter to find a better clone of 'Discovery' than the standard because a new clone has to be superior in all respects. None of the new clones represent a striking improvement of 'Discovery.'

Glim cannot be recommended because of low productivity (Table 2) and susceptibility to fruit tree canker. II A 1366 was found to have visually attractive fruits (Table 4) but unfortunately the yield of well-colored fruits was low (Table 3).

Big fruits with a high percentages red coloration is a desirable quality for a new clone. Nykoebing S and II A 1327 are lower yielding clones (Table 2) but the yield of well colored fruits are high for Nykoebing S both years and for II A 1327 one year.

LA 73A represent the best alternative to H 4108 with 13% higher cumulative fruit production (Table 2) but the higher yield is not obtained by more Class 1 fruit. LA 73 A does not represent a better-colored clone than H 4108 (Table 3). Visual evaluation of appearance (Table 4) and percent of total first class fruit (Table 3) showed no significant difference between the two clones. So the fruit quality with LA 73A is similar as with H 4108.

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