

## EFFICACY OF NATURAL COMPOUNDS USED FOR THINNING IN ORGANIC APPLE ORCHARDS

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### A B S T R A C T

In organic fruit production the use of chemical-synthetic thinning agents or plant hormones for crop regulation is not allowed. To replace them, trials on thinning by means of substances occurring naturally in the environment, which can damage the weaker flowers or affect pollen germination adversely, were conducted in Poland in 2003-2005 on apple trees cvs. 'Gala Must', 'Jonagold Decosta', 'Golden Delicious' and 'Šampion'. It was found that Olejan 85 EC (85% rape oil) reduced fruit set, positively affected apple size, commercial yield, the red colour of apples, and sometimes, flowering in the next year. However, it also produced phytotoxic effects and increased russeting of fruits. Another preparation – NuFilm 96 EC (di-1-P-menthene) improved flower vigour and apple surface quality. Most frequently, it did not affect, let alone improve, fruit set. In spite of that, it often caused an increase in fruit size. Sometimes, it also reduced the red colour, firmness, and refraction of apples as well as subsequent blooming. Another preparation tested – Biochicol 020 PC (chitosan) produced no thinning effect but distinctly improved the vigour of flowers and leaves, which sometimes resulted in a better growth of fruits and a more intense red colour on the fruit surface with slightly less russeting. Other preparations – garlic soap and Bioczoz (an extract of garlic), used as a mixture, did not show thinning effects, but reduced russeting and sometimes increased fruit weight.

**Key words:** organic production, apple, thinning, fruit set, fruit quality

### INTRODUCTION

Because of the growing interest in eco-friendly fruit production there is a need to develop methods of controlling the growth and fruiting of trees by employing compounds, preferably of natural origin, that are

safe for the environment and the consumer (Basak, 2004). Agents used in organic orchards require special selection. For several years research has been carried out on assessing the effectiveness of various organic substances in thinning fruitlets (Hobl et al., 2003; Basak,

2004). Out of those already tested, the largest amount of information, and the most promising at that, has been collected following the use of substances which burn weaker flowers, including natural oils, mainly rapeseed, sunflower, soybean, corn, and fish oil, as well as sulphur lime (Melland, 1998; Pfeiffer and Ruess, 2002; Stopar, 2004; Warlop et al., 2003; Fallahi and Fallahi, 2006). Sometimes, thinning of flowers/fruitlets is caused by substances such as table salt, soap, molasses, dextrin and others (Stopar, 2004; Embree and Foster, 1999; Weibel and Walther, 2003), and substances that cover the stigma, thus preventing or hampering pollen germination and pollen-tube growth, such as Safer-Soap (potassium salts of fatty acids), PEG-1000(HO(-CH<sub>2</sub>CH<sub>2</sub>O)-NH), Anti-Stress (acrylic polymers), Nutri-Safe (N,O-carboxy-methylchitosan), Bio-film (alkylaryl-polyethoxy ethanol + fatty acids + phosphatic acids + isopropanol) (Bertshinger et al., 1998; Embree and Foster, 1999).

The aim of the work was to study the effect of a few preparations containing natural substances in the hope of using them for proecological thinning in organic apple orchards. Research work was belonging to the European Fruit Research Institutes Network (EUFRIN) Working Group on Fruit Chemical Thinning activities.

## MATERIAL AND METHODS

The research was conducted over three years, 2003-2005, in the Experimental Orchard of the Institute

of Pomology and Floriculture in Dąbrowice near Skierniewice. It involved 6- to 8-year-old apple trees of the cultivars 'Jonagold Decosta', 'Golden Delicious', 'Gala Must' and 'Šampion' growing on M.9 rootstock spaced at 3.5 x 1.5 m, in neighbouring rows of trees on the same plot, that is in similar soil and climatic conditions.

The following organic preparations were tested:

- Olejan 85 EC – containing 85% rape oil – a preparation causing blistering
- NuFilm 96 EC – contains di-1-P-menthene obtained from American pine, which, when applied to a plant, forms a transparent biodegradable film.
- Biochicol 020 PC – contains chitosan (derived from shellfish coats). It was introduced recently to organic orchards as a pesticide.
- Bioczos and garlic soap made from garlic and containing film-forming substances and antiseptic and antioxidant ingredients.
- Sodium chloride and potassium soap. In this case advantage is taken of the blistering properties of these substances.
- Sulphur lime (CaS<sub>x</sub>) – a natural mineral substance used in the past for thinning purposes.

The different thinning programmes were tested in the following experiments (years).

In 2003 (*Experiment 1*), 'Gala Must' trees were sprayed with Olejan 85 EC at 2% and 3% on May 9 (Date 1) and May 12 (Date 2). Another

preparation, NuFilm 96 EC, was used at 1 and 2% in the same way. The trees were sprayed once (Date 1) or twice (Dates 1 and 2).

In 2004 (*Experiment 2*), the experiments with Olejan 85 EC and NuFilm were continued on 'Jonagold Decosta' and 'Golden Delicious' trees. Both preparations were applied in two concentrations and on two dates (as in Table 2 and 3). Moreover, the preparation Biochicol, containing chitosan, was applied to those trees on the earlier date (Date 1). In the same experiment, sodium chloride (NaCl) at concentrations of 1% and 1.5%, the mixture of sodium chloride at 1% with NuFilm 96 EC at 1%, potassium soap at 1% and 1.5%, and sulphur lime at 2% and 3% were used on 'Šampion' apple trees at full bloom.

In 2005 (*Experiment 3*), the following treatments were applied on Date 1 to 'Jonagold Decosta' and 'Golden Delicious' trees: the new formulation of Olejan 85 EC in concentrations of 2% and 3%, NuFilm 96 EC at 2% and 3%, and the mixture of 0.05% garlic soap and 1% Bioczoz.

The preparations were applied by heavily and evenly spraying the tree crowns during the full bloom on 2-year-old shoots, 3 days after the central flowers had opened up (Date 1), and in the first and second year of the trials also during the full bloom on 1-year-old shoots (Date 2), assuming consumption of 1000 litres of the solution per 1 ha of orchard.

The following measurements were performed:

1. The initial fruit set (%), i.e. two weeks after bloom, and the final fruit set (%), i.e. after the June drop at the end of June and at the beginning of July. The fruit set was expressed as the number of fruit from 100 inflorescences;
2. Yield in kg/tree;
3. Mean fruit weight (g);
4. Distribution of fruits in size classes based on their diameter in the range of 55-90 mm, and the percentage of apples of commercial value, i.e. with diameter > 70 mm;
5. Distribution of fruits in 5 russetting classes: 1 – no russetting, 2 – russetting on 1-25% of surface, 3 – russetting on 26-50% of surface, 4 – russetting on 51-75% of surface, 5 – russetting on > 75% of surface;
6. Distribution of fruits in coloration classes based on the size of the surface area covered by a red blush, in 5 classes as for russetting;
7. Flowering intensity in the subsequent year according to a 5-point scale on which 1 means no flowers and 5 very abundant flowering.

The results obtained following the use of the preparations were compared with similar measurements for unsprayed control trees and trees that were not sprayed but thinned by hand after the June drop in the way adopted in commercial orchards. For each experimental combination, 6-8 trees with a similar growth vigour and flowering intensity were selected randomly along the tree rows (1 tree = replication). The results of the

experiments were subjected to an analysis of variance and Duncan's multiple range test at the 5% level of significance was used for means separation.

## RESULTS AND DISCUSSION

The trials conducted on apple trees of the different cultivars over three seasons did not produce results which could allow the use of the tested preparations in commercial organic orchards. The main reason was phytotoxicity of some of the tested preparations or their thinning efficiency being too low. We concluded that the efficiency of organic preparations is lower and less predictable than that of the synthetic preparations used for similar purposes up to now. It is possible that the organic preparations could be used in a joint programme with selected synthetic preparations at low doses to increase their efficiency and safety for the environment and the consumer.

*Experiment 1.* None of the preparations used on 'Gala Must' brought about a significant reduction in fruit set, but NuFilm 96 EC applied earlier and at the lower concentration even increased fruit set significantly (Tab. 1). Nevertheless, both of these preparations probably hindered pollen-tube growth and fertilization of flowers since the fruits from the treated trees contained less fertile seeds (data not shown). These properties were discovered by Embree and Foster (1999) when the preparation Biofilm was used in

experiments on thinning. Olejan 85 EC produced phytotoxic effects, especially at the higher concentration applied on the later date. In experiments by other authors, the use of colza (rape) oil for thinning caused severe damage to leaves, too (Stopar, 2004). It would probably be possible to reduce phytotoxicity by an earlier application of the oil, e.g. at the start of blooming (ZhiGuo et al., 2001).

The fruits from all the thinned trees were significantly larger compared to the unthinned control. An especially significant increase in fruit weight was observed under the influence of Olejan. A marked increase in the commercial yield (fruits > 70 mm in diameter) was also found, but the distribution of apples in the size groups was more uniform and the size grading value was significantly increased. NuFilm 96 EC also influenced positively the value of the commercial yields and size grading, but only when it was applied on the second date (Tab. 1).

All apples in this experiment were well-coloured, but those from Olejan 85 EC-sprayed trees showed better coloration. The trees treated with NuFilm 96 EC once on the second date were less coloured, but the application of the same preparation twice influenced the coloration to a greater extent. The positive effect of NuFilm 96 EC on fruit size and apple colour is likely to be a consequence of a reduction in evapotranspiration and protection against ultraviolet light (Technical Data Sheet of Miller Chemical & Fertilizer Corp., USA).

Table 1. Results of thinning trials on 'Gala Must' apple trees in 2003

| Treatment           | Final fruit set [%] | Mean fruit weight [g] | Total yield [kg/tree] | % apples > 70 mm [no./tree] | Grading index <sup>a</sup> | % apples with red colour > 75% | Color index <sup>b</sup> | Blooming next year (5 <sup>0</sup> scale) |
|---------------------|---------------------|-----------------------|-----------------------|-----------------------------|----------------------------|--------------------------------|--------------------------|---|
| Control – unthinned | 78.6 a              | 79 a                  | 44.9 a-c              | 7.7 a                       | 310 a                      | 62.3 c-e                       | 794 d-f                  | 3.8 b-d                                   |
| Olejan 85 EC        |                     |                       |                       |                             |                            |                                |                          |   |
| 2% T1*              | 87.5 a-c            | 141 d                 | 35.4 a                | 55.0 d                      | 459 f                      | 80.5 e                         | 839 f                    | 4.9 f                                     |
| 2% T2**             | 73.6 a-c            | 125 b-d               | 52.1 c                | 33.2 b-d                    | 403 c-f                    | 68.4 de                        | 806 ef                   | 3.8 b-d                                   |
| 3% T2               | 71.0 a              | 141 d                 | 50.4 bc               | 54.2 d                      | 454 ef                     | 57.7 b-d                       | 788 d-f                  | 4.6 ef                                    |
| NuFilm 96 EC        |                     |                       |                       |                             |                            |                                |                          |   |
| 1% T1*              | 105.8 c             | 109 bc                | 48.0 bc               | 18.2 a-c                    | 361 a-c                    | 52.2 a-d                       | 758 b-f                  | 3.3 a-c                                   |
| 1% T2**             | 86.7 a-c            | 127 b-d               | 49.1 bc               | 38.8 cd                     | 414 c-f                    | 41.1 a-c                       | 718 b-d                  | 2.9 a                                     |
| 1% T1 + T2          | 80.5 ab             | 115 b-d               | 34.3 a                | 22.6 a-c                    | 337 ab                     | 68.0 de                        | 787 d-f                  | 3.5 a-d                                   |
| 2% T1               | 76.1 a              | 107 b                 | 48.7 bc               | 14.1 ab                     | 361 a-c                    | 55.1 a-d                       | 770 c-f                  | 3.1 ab                                    |
| 2% T2               | 72.4 a              | 127 b-d               | 39.2 ab               | 31.9 b-d                    | 401 c-e                    | 41.2 a-c                       | 734 b-e                  | 3.1 ab                                    |
| 2% T1 + T2          | 83.5 ab             | 119 b-d               | 50.3 bc               | 19.3 a-c                    | 375 b-e                    | 61.4 c-e                       | 806 ef                   | 3.9 b-d                                   |

Explanation: Means in columns followed by the same letters are not significantly different at the 5% level of significance according to Duncan's multiple range t-test

\*preparation used at full bloom on old wood – Date 1

\*\*preparation used at full bloom on 1-year old wood – Date 2

<sup>a</sup>Grading index = [ $n_1 \times 1(<55) + n_2 \times 2(56-60) + n_3 \times 3(61-65) + n_4 \times 4(66-70) + \dots + n_{10} \times 10(96-100)$ ]; n = the number of fruits in each class according to the national standard in 5 mm weight classes

<sup>b</sup>Red colour/russetting index = [ $n_1 \times 1(\text{class } 1) + n_2 \times 3(\text{class } 2) + n_3 \times 5(\text{class } 3) + n_4 \times 7(\text{class } 4) + n_5 \times 9(\text{class } 5)$ ]; n = the number of fruits in classes: 1 = 0%, 2 = < 25%, 3 = 26 – 50%, 4 = 51 – 75%, 5 = > 75% surface with red colour or russeted

The application of NuFilm 96 EC lowered firmness and sometimes also refraction of the apples, although insignificantly. Olejan 85 EC showed no influence on these parameters. Both preparations, especially when applied later, made the fruit shape more elongated, probably due to the marked increase in fruit weight.

A single treatment with Olejan 85 EC at 2% on the first date and at 3% on the second date caused significantly better flowering of the trees in the next year, in spite of the severe damage to the leaves the year before. NuFilm 96 EC, on the contrary, caused a reduction in flowering in the next year when it was applied on the second date, and especially at the lower dose (1%). More basic information on the mechanism of NuFilm's action (and pinolenes in general) would be helpful in explaining its effect on subsequent flowering.

*Experiment 2.* In the trees of cv. 'Jonagold Decosta', the preparation Olejan 85 EC caused a distinct reduction in the initial fruit set, especially when it was used early. The final fruit set was lowered (but insignificantly) when the preparation was used at the higher dose and on the earlier date only (Tab. 2). All the treatments with Olejan 85 EC increased the size of apples and in most cases the differences from the control were significant. Olejan 85 EC did not influence the total and commercial yield very often or flowering in the next year. The red colour of apples was more intense

and the number of apples free of russetting decreased significantly. Olejan produced phytotoxic effects, especially when applied late and at the higher concentration (3%).

The preparation NuFilm generally acted very weakly. Besides a small reduction in the initial fruit set due to its early application, it did not reduce the final fruit set and did not influence the yield, the parameters of fruit quality and flowering in the next year.

Biochicol did not give the expected results, either. It only improved coloration slightly and reduced russetting insignificantly. Another preparation containing chitosan, under the trade name of Nutri-Save, acted as a pollination enhancer in the thinning trials conducted in Canada by Embree and Foster (1999).

In 'Golden Delicious' trees, Olejan 85 EC reduced the final fruit set, but only when applied at the higher concentration on the earlier date (Tab. 3). The size of apples and the commercial yield were significantly higher than in the control trees, but the total yield decreased, especially when the preparation was applied early. Nevertheless, Olejan 85 EC caused russetting to be more pronounced, especially after the late spraying with the preparation. There was no influence on flowering in the next year.

The effect of NuFilm 96 EC on 'Golden Delicious' flowers was contrary to expectation: it strengthened the flowers and improved fruit set, significantly increased the commercial yield and improved fruit size in most treatments in spite of the lack of

Table 2. Results of thinning trials on 'Jonagold Decosta' apple trees in 2004

| Treatment           | % fruit set |          | Mean fruit weight [g] | Yield           |                   | Apples free of russetting [%] | Apples with red colour > 75% surface |
|---------------------|-------------|----------|-----------------------|-----------------|-------------------|-------------------------------|--------------------------------------|
|                     | Initial     | final    |                       | total [kg/tree] | > 70 mm [kg/tree] |                               |                                      |
| Control – unthinned | 265.4 c     | 75.3 a-d | 187 ab                | 42.9 b          | 13.5 a            | 82.4 de                       | 16.5 a                               |
| Hand-thinned        | 273.1 c     | 44.1 a   | 249 d                 | 33.4 ab         | 14.8 a            | 87.9 e                        | 52.5 d                               |
| Olejan 85 EC        |             |          |                       |                 |                   |                               |                                      |
| 2% T1               | 157.3 a     | 67.0 a-d | 218 b-d               | 34.7 ab         | 14.2 a            | 66.4 bc                       | 34.6 b-d                             |
| 2% T2               | 225.4 a-c   | 62.8 a-c | 248 d                 | 36.5 ab         | 14.3 a            | 59.4 ab                       | 43.0 cd                              |
| 3% T1               | 166.8 ab    | 51.7 ab  | 239 d                 | 39.7 ab         | 13.8 a            | 60.6 ab                       | 48.7 d                               |
| 3% T2               | 191.7 a-c   | 73.3 a-d | 220 cd                | 31.2 a          | 13.6 a            | 48.4 a                        | 34.7 b-d                             |
| NuFilm 6 EC         |             |          |                       |                 |                   |                               |                                      |
| 1% T1               | 223.0 a-c   | 94.6 b-d | 179 a                 | 33.9 ab         | 13.5 a            | 76.0 cd                       | 20.2 ab                              |
| 1% T2               | 254.7 c     | 106.1 d  | 183 a                 | 36.1 ab         | 14.1 a            | 80.7 de                       | 23.0 ab                              |
| 2% T1               | 238.4 bc    | 91.6 bd  | 201 a-c               | 35.0 ab         | 13.8 a            | 81.5 de                       | 26.8 a-c                             |
| 2% T2               | 242.8 bc    | 82.5 a-d | 181 a                 | 36.1 ab         | 13.4 a            | 80.1 de                       | 27.2 a-c                             |
| Biochicol 020 PC    | 259.0 c     | 2.1 a-d  | 189 ab                | 33.8 ab         | 14.1 a            | 89.2 e                        | 23.22 ab                             |
| 2% T1               |             |          |                       |                 |                   |                               |                                      |

Explanations as in Table 1

Table 3. Results of thinning trials on 'Golden Delicious' apple trees in 2004

| Treatment           | % fruit set |           | Mean fruit weight [g] | Yield           |                   |                    | Apples free of russetting [%] |
|---------------------|-------------|-----------|-----------------------|-----------------|-------------------|--------------------|-------------------------------|
|                     | initial     | final     |                       | total [kg/tree] | > 70 mm [kg/tree] | > 70 mm % of total |                               |
| Control – unthinned | 244.9 a-d   | 82.4 a-d  | 122 a                 | 45.6 d          | 6.0 a             | 39.9 a             | 58.0 b-e                      |
| Hand-thinned        | 280.8 cd    | 50.2 a    | 164 f                 | 32.1 ab         | 11.7 f            | 86.0 g             | 68.3 d-f                      |
| Olejan 85 EC        |             |           |                       |                 |                   |                    |                               |
| 2% T1               | 250.3 a-d   | 94.1 b-e  | 152 e                 | 34.8 a-c        | 10.5 d-f          | 75.2 ef            | 43.3 a-c                      |
| 2% T2               | 221.6 a-c   | 87.6 b-e  | 141 b-e               | 39.1 b-d        | 9.3 c-e           | 65.5 b-f           | 34.7 a                        |
| 3% T1               | 185.5 ab    | 69.7 ab   | 146 c-e               | 33.0 ab         | 10.3 d-f          | 72.6 d-f           | 41.2 ab                       |
| 3% T2               | 179.4 a     | 88.6 b-e  | 137 b-d               | 37.7 a-d        | 8.3 b-d           | 60.5 b-d           | 30.3 a                        |
| NuFilm 96 EC        |             |           |                       |                 |                   |                    |                               |
| 1% T1               | 202.6 a-c   | 91.6 b-e  | 144 b-e               | 38.4 a-d        | 9.1 c-e           | 63.8 b-f           | 67.1 c-f                      |
| 1% T2               | 273.2 b-d   | 104.0 b-e | 134 a-d               | 37.4 a-d        | 8.2 a-d           | 53.8 ab            | 70.5 d-f                      |
| 2% T1               | 279.3 cd    | 108.4 c-e | 140 b-e               | 42.3 cd         | 9.3 c-e           | 59.4 b-d           | 61.1 b-f                      |
| 2% T2               | 252.0 a-d   | 120.1 e   | 137 b-d               | 42.0 cd         | 9.0 c-e           | 58.2 bc            | 61.6 b-f                      |
| Biochicol 020 PC    | 251.7a-d    | 107.9 c-e | 137 b-d               | 40.4 b-d        | 8.2 a-d           | 57.2 bc            | 58.5 b-e                      |
| 2% T1               |             |           |                       |                 |                   |                    |                               |

Explanations as in Table 1

thinning. It also slightly increased the number of fruits free from russetting. The fruits distinguished themselves by a beautiful, smooth and shining skin. There was no influence on flowering in the next year.

Biochicol significantly improved the quality of 'Golden Delicious' flowers and leaves, the consequence of which was a significant increase in the mean fruit weight and significantly more apples of commercial value in the total yield in spite of no thinning effect. The plant protection properties of this preparation were the likely reason for the advantageous effect on flower and fruit quality (personal communication).

In 'Šampion', the effects of sodium chloride, soap solution, and sulphur lime were not satisfactory, although the fruits were better coloured and the trees flowered better in the next year, especially after the application of sulphur lime (data not shown).

*Experiment 3.* In 'Jonagold Decosta' trees, none of the preparations tested caused a significant reduction in fruit set and no effect on subsequent blooming was noticed (Tab. 4). Olejan, applied as a new, improved formula, did not exhibit phytotoxicity and did not increase russetting. It caused a distinct improvement in fruit size and in the commercial yield value, although this effect was not proven statistically. It did not influence the internal quality of the fruits expressed by their firmness and the refraction value of the sap.

The preparation NuFilm 96 EC caused only a slight increase in apple size and the commercial yield, and slightly reduced the firmness of apples (data not shown).

Garlic soap was most efficient when used in a mixture with the preparation Bioczos. This mixture improved apple size and reduced russetting, significantly in comparison with the control. The mixture did not affect the internal quality of apples.

In 'Golden Delicious' trees, the new formulation of the preparation Olejan did not affect fruit set or fruit size. At the higher concentration, it lowered the number of apples free of russetting and caused a reduction in the total yield. Simultaneously, this treatment improved the red colour of apples (Tab. 5).

On the other hand, NuFilm 96 EC decreased fruit set from 73% in the control trees to 65%, but did not affect fruit size or the yield. Russetting diminished markedly.

The mixture of garlic soap and Bioczos, apart from producing a slight reduction in fruit set, prevented russetting. For instance, the percentage of apples without russetting increased to 51.3% (36.4% in the control). From this point of view, the mixture of the garlic preparation acted better than hand thinning.

## CONCLUSIONS

*Olejan 85 EC* reduced fruit set, especially the initial one. It acted most efficiently when applied early, during the full bloom on 2-year-old wood and at the higher concentration. This preparation positively affected

Table 4. Results of thinning trials on 'Jonagold Decosta' apple trees in 2005

| Treatment                               | Fruit set [%] | Mean fruit weight [g] | Yield > 70 mm [kg/tree] | Total yield [kg/tree] | Colour index | Russetting index | Subsequent blooming on 5 <sup>0</sup> scale |
|---|---------------|-----------------------|-------------------------|-----------------------|--------------|------------------|---|
| Control – unthinned                     | 74.5 ab       | 188 ab                | 85.4 ab                 | 39.6 a                | 770 ab       | 241 ab           | 1.7 ab                                      |
| Hand-thinned                            | 51.7 a        | 223 c                 | 92.9 b                  | 39.3 a                | 829 b        | 237 ab           | 2.2 b                                       |
| Olejan 85 EC 2%                         | 68.9 ab       | 202 bc                | 88.9 b                  | 42.7 a                | 791 ab       | 266 ab           | 1.8 ab                                      |
| Olejan 85 EC 3%                         | 66.9 ab       | 198 bc                | 91.9 b                  | 45.4 a                | 767 ab       | 255 ab           | 1.9 ab                                      |
| Mixture: Bioczos 1% + Garlic soap 0.05% | 71.3 ab       | 201 bc                | 89.9 b                  | 47.9 a                | 796 ab       | 231 ab           | 1.8 ab                                      |
| NuFilm 96 EC 2%                         | 78.5 b        | 199 bc                | 87.9 b                  | 44.2 a                | 796 ab       | 244 ab           | 1.8 ab                                      |
| NuFilm 96 EC 3%                         | 65.5 ab       | 195 ab                | 87.4 b                  | 45.7 a                | 787 ab       | 239 ab           | 1.6 ab                                      |

Explanations as in Table 1

Table 5. Results of thinning trials on 'Golden Delicious' apple trees in 2005

| Treatment                               | Fruit set [%] | Mean fruit weight [g] | Yield > 70 mm [kg/tree] | Total yield [kg/tree] | Colour index | Russetting index | Subsequent blooming on 5 <sup>0</sup> scale |
|---|---------------|-----------------------|-------------------------|-----------------------|--------------|------------------|---|
| Control – unthinned                     | 73.1 b        | 130 a                 | 34.7 a                  | 56.1 b                | 301 a        | 250 bc           | 1.3 ab                                      |
| Hand-thinned                            | 46.6 a        | 143 b                 | 61.5 b                  | 47.5 ab               | 303 a        | 224 ab           | 1.5 b                                       |
| Olejan 85 EC 2%                         | 64.4 b        | 122 a                 | 22.5 a                  | 55.6 b                | 300 a        | 228 ab           | 1.0 a                                       |
| Olejan 85 EC 3%                         | 77.9 b        | 131 a                 | 41.0 ab                 | 42.5 a                | 311 b        | 281 c            | 1.5 b                                       |
| Mixture: Bioczos 1% + Garlic soap 0.05% | 67.0 b        | 129 a                 | 36.5 a                  | 53.7 ab               | 301 a        | 206 a            | 1.0 a                                       |
| NuFilm 96 EC 3%                         | 65.0 b        | 123 a                 | 26.5 a                  | 53.4 ab               | 305 ab       | 223 ab           | 1.0 a                                       |

Explanations as in Table 1

apple size, the commercial yield, fruit coloration and, sometimes, flowering in the next year. It produced phytotoxic effects and increased russetting.

Improvements in the new formula of Olejan 85 EC eliminated the phytotoxic effects, but only slightly alleviated its russetting effect. Some

authors suggest avoiding these negative side effects by using oils for thinning earlier, at the beginning of bloom (Stopar, 2004).

*NuFilm 96 EC* improved flower vigour and prolonged flowering time, but most frequently it did not influence or even ameliorate fruit set. In spite of that, *NuFilm* frequently caused an increase in fruit size, especially when spraying was performed later, i.e. at the full bloom. Sometimes, *NuFilm 96 EC* made the coloration, firmness and the refraction value of the sap worse, as well as flowering in the next year. Nevertheless, it reduced russeting and contributed to a better appearance of the skin. As was shown in another of our experiments (data not shown), *NuFilm 96 EC* should be mostly used for this purpose. The best results were obtained when *NuFilm 96 EC* was used a few times at intervals of a few days.

*Biochicol 020 PC* produced no thinning effect. It distinctly improved the vigour of flowers and leaves, which resulted in a somewhat better fruit growth, somewhat better coloration and slightly less russeting. It may act as a pollination enhancer, like the preparation *Nutri-Save* in a Canadian experiment (Embree and Foster, 1999).

The application of *sodium chloride*, *soap solution* and even *sulphur lime* did not give satisfactory results with the cultivar *Šampion*. The experiments with these substances should be repeated in Poland. In spite of producing a strong phytotoxic effect, sulphur lime belongs to one of

the most promising organic fruit-thinning compounds (Stopar, 2004). Also, the good effect of sodium chloride on the subsequent blooming of apple trees, in spite of a weak thinning effect, is worthy of attention (Stopar, 2004).

*Garlic soap* in a mixture with *Bioczoz*, did not show, in general, any thinning effect, but reduced russeting. Sometimes, it increased the weight of apples without influencing their internal quality. Thus, applying these preparations for plant protection also causes an improvement in the final appearance of apples because they cause a reduction in russeting.

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# SKUTECZNOŚĆ ZWIĄZKÓW NATURALNYCH ZASTOSOWANYCH NA JABŁONIE DO PRZERZEDZANIA W SADACH ORGANICZNYCH

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## S T R E S Z C Z E N I E

W sadach organicznych stosowanie preparatów chemicznych i substancji wzrostowych do przerzedzania zawiązków jest niedozwolone. W związku z tym poszukiwane są preparaty pochodzenia naturalnego, które zastąpiłyby preparaty syntetyczne. W badaniach wykonanych w latach 2003-2005 na jabłoniach odmian 'Gala Must', 'Jonagold Decosta', 'Golden Delicious' i 'Szampion' oceniano efekty przerzedzania po zastosowaniu kilku substancji występujących w środowisku naturalnie. Stwierdzono, że: Olejan 85 EC (zaw. 85% oleju rzepakowego) redukowało zawiązywanie owoców, korzystnie wpływał na ich wielkość, plon handlowy, czerwone wybarwienie jabłek i czasem na kwitnienie drzew w roku następnym. Jednak działał fitotoksycznie i nasilał ordzawianie jabłek. Inny preparat – NuFilm 96 EC (zawierający naturalny di-1-P-menten) poprawiał jakość kwiatów oraz ogólny wygląd owoców. Najczęściej nie redukowało, a nawet zwiększało zawiązanie owoców. Pomimo tego, często powodował przyrost wielkości jabłek. Czasem, także redukowało wybarwienie, jędrność i refrakcję jabłek oraz pogarszał następne kwitnienie drzew. Inny testowany preparat – Biochicol 020 PC (zawierający naturalny chitozan) nie przerzedzał, lecz wyraźnie poprawiał jakość kwiatów i liści, co czasem spowodowało lepsze wyrastanie owoców, bardziej intensywne ich wybarwienie i redukcję ordzawienia. Natomiast, mydło czosnkowe zastosowane w mieszaninie z preparatem Bioczoz (zawierającym ekstrakt czosnku) redukowało ordzawienia i czasem powodowało przyrost wielkości jabłek pomimo braku wpływu na zawiązywanie owoców.

**Słowa kluczowe:** produkcja organiczna, jabłonie, przerzedzanie, zawiązanie owoców, jakość owoców