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CHANGES OF CHLOROPHYLL CONTENT IN SPRING RAPE SEED IN RELATION TO MOISTURE CONTENT AND TEMPERATURE OF THE SEED AFTER HARVEST

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Since 1970 Swedish farmers are paid for the seed yield of oil crops according to the chlorophyll content in the oil. Naturally, the moisture and oil content is also taken into account. This regulation according to chlorophyll content was introduced in order to stimulate all efforts to avoid high chlorophyll content in the oil from Swedish grown oil seed.

Table 1: Price regulations in 1973 according to chlorophyll content

Chlorophyll content, ppm	Reduction of the price[1], per cent
⩽ 30	none
30- 70	0.15 % per ppm above 30
70-110	6 % + 0.125 % per ppm above 70
110-200	11 % + 0.1 % per ppm above 110
⩾ 200	20 %

1) The price calculated with reference to moisture and oil content

The influence of high chlorophyll content in the oil seed on the price to the farmer can be seen from table 1.

High chlorophyll contents are relatively often found in Swedish grown oil seed, depending on many factors such as species, cultivars, growing conditions and cultivation technique. Under Swedish conditions winter rape has normally a higher chlorophyll content than winter turnip rape, and spring rape a higher content than white mustard and spring turnip rape. It is often difficult to get well developed, uniform stands after the damage occurring during the overwintering periods. It is also difficult to get well established, dense stands of spring sown oil crops in Sweden, especially in the eastern part of the country up to about 200 km north of Stockholm, the approximate limit for spring sown oil crops, because of frequently dry weather conditions in spring and early summer. In the northern part of the oil crop area in Sweden we may also have problems with the late ripening of spring sown oil crops on account of early frosts which disturb the normal ripening process and result in a high chlorophyll content in the seeds at harvest.

Apart from the influences of species and weather, many of the farmer's operations affect the chlorophyll content of the harvested material. Among these can be mentioned seeding time, seed rate, row space, nitrogen fertilization and harvest time. In the uneven stands of rape and turnip rape that often occur in Sweden there will, however, normally be little possibility of avoiding unripe seeds in the yield by waiting for all seeds to reach the right ripening stage for harvest. Is it then possible to handle the yield

before or during the artificial drying in a way that reduces the high chlorophyll content to an acceptable level for the industry, e.g. preferably below 30 ppm. This problem has been studied in some investigations, e.g. in Canada but also in Sweden (LÖÖF, 1966; LÖÖF and JOHANSSON, 1969; APPELQVIST and OHLSON, 1972). More studies of the problem was, however, found to be of interest as the conditions in Middle Sweden due to the northern location could be expected to have a special influence. Consequently an investigation in spring rape was started in 1971 at the Department of Plant Husbandry at the Agricultural College in order to study the changes of the chlorophyll content in the seed of spring rape in relation to the ripening stage at harvest and the storage conditions up to 4 weeks after harvest. The investigation has been in process during the years 1971-1973.

The plan for the investigation can be briefly described as follows: Spring rape is combine-harvested and swathed and threshed respectively at 6 different ripening stages - starting when the moisture content of the seed is about 40 per cent and ending at the stage when it has decreased to about 15 per cent. The seed yield after combine harvest is divided into 6 portions, of which 5 are then stored for 4 weeks at different temperatures in the range between $+25^{\circ}$ C and -5° C. The sixth portion is dried at a temperature of $30\text{-}35^{\circ}$ C immediately after harvest.

The swathed material is threshed when the moisture content - if possible - under field conditions has decreased to below 20 per cent.

During the four-week period 7 samples per temperature level are taken and dried at $30\text{-}35^{\circ}$ C.

Samples from all treatments are analyzed for their contents of oil and chlorophyll and content of free fatty acids. The content of free fatty acids was not analyzed in 1971. Some samples are also analyzed for germinability, thousand kernel weight and fungi attacks.

As the samples were stored in small open containers the moisture content decreased more or less rapidly during the four-week period. To avoid the effect of having the seeds dried to different levels because of the different storage conditions we have had 2 samples at each temperature during the last two years - one sample with the seed in a small open container and one sample in an air-tight container.

Results

As the investigation will be continued during 1974 it is not possible to give final results today but some results, especially concerning chlorophyll content, will be very briefly presented in the following. (More detailed results from the first year are presented by GOTTFRIDSSON, 1971).

Chlorophyll content decrease in relation to moisture content at harvest

In agreement with results from other investigations it can be stated that the decrease in chlorophyll content after harvest is very dependent on the moisture content in the seeds. This can be illustrated with the figures for the relative change in chlorophyll content of material harvested at different stages of ripening (table 2)

Table 2: Change in chlorophyll content in relation to the moisture content of the seed at harvest, 1971

Moisture content at harvest, per cent	Relative decrease in chlorophyll content during 3 weeks storage, without artificial drying (average for all storing temperatures)
43	50 per cent
37	39 per cent
31	32 per cent
26	3 per cent
20	4 per cent

It seems necessary to have a moisture content above 25 per cent if a more pronounced decrease in the chlorophyll content is required. On average for 1971 and 1972 we found that seeds harvested at moisture contents above 30 per cent had only half the original chlorophyll content left after three days storage while seeds harvested at about 15 per cent moisture content under the same conditions showed only a 10-20 per cent decrease of the chlorophyll content (Figure 1 and 2).

In connection with the results presented in Table 2 and Figure 1 it can be mentioned that there is not a very close conjunction between moisture content and chlorophyll content of the seed yield when the relationship is studied over a number of years. In 1971, when the material was taken from a very uneven stand, the 31 per cent moisture content represents a higher chlorophyll content in the seed yield than 34 per cent in 1972, when the spring rape stand was very uniform (Figure 2).

Chlorophyll content decrease in relation to storage temperature

The decrease in chlorophyll content after harvest also depends on the temperature of the seed. Storage of undried seeds at higher temperature than $+10^{\circ}$ C gave a much more rapid chlorophyll content decrease than storage at lower temperatures (Table 3).

The figures in Table 3 indicate that there is an interaction between moisture content and temperature - the higher the moisture content the greater is the effect of the high temperatures. At low moisture content levels there are no significant differences between different storage temperatures with regard to their influence on the reduction of the chlorophyll content.

Figure 1. Changes in chlorophyll content during storage at about +20° C

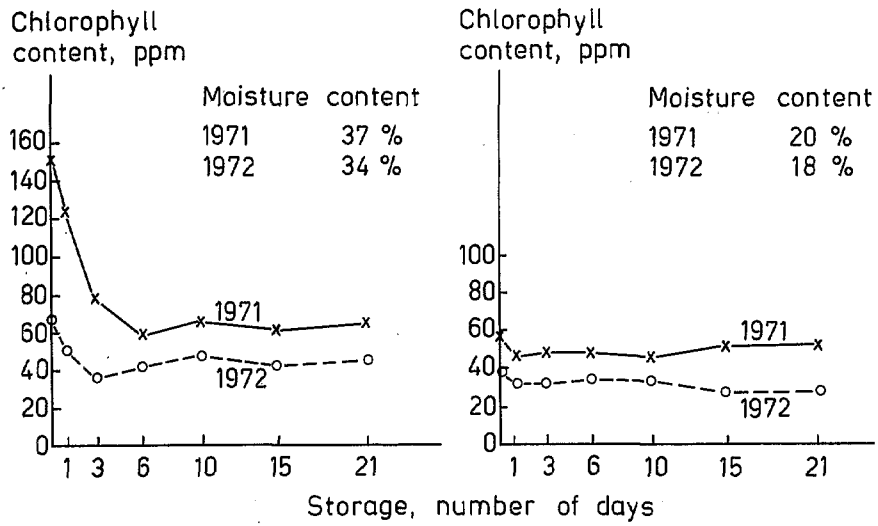

Figure 2. Changes in chlorophyll content during storage at about +20° C

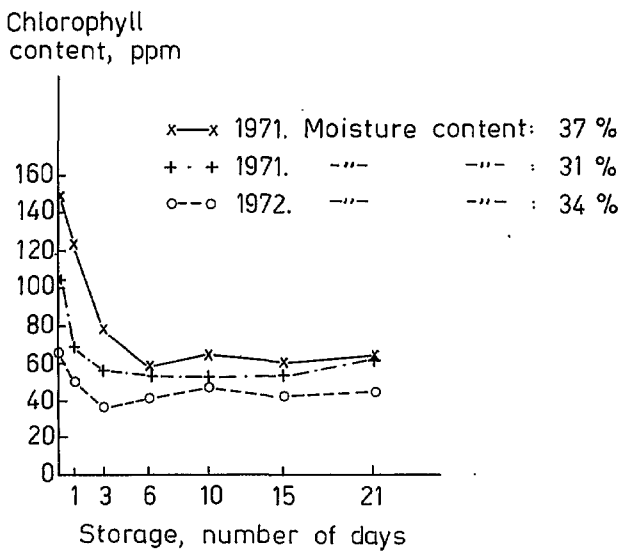

Table 3: Change in chlorophyll content in relation to moisture content at harvest and storage temperature as well as change in chlorophyll content in swathed material, 1971

Moisture content at harvest, per cent	Relative decrease in chlorophyll content of undried seed during 4 weeks storage at		Relative decrease in chlorophyll content of seed from swathed material
	+10° C	+5° C	
43	75	51	67
31	39	29	14
20	11	14	4

Even when we have normally had the most striking effect on the reduction of chlorophyll content from high temperatures in combination with high moisture content, we sometimes got an increase in the chlorophyll content under these conditions.

The figures in Tables 2 and 3 also show that swathing the material before threshing has had a very good reducing effect on the chlorophyll content of the seed yield. But it seems also obvious that the reducing effect of swathing is to a high extent dependent on the temperature; swathing the material as a method to reduce the chlorophyll content of the seed yield has been superior to storage of the seed yield at +5° C but inferior to storage at +10° C.

Changes in oil content, germinability and thousand kernel weight of the seed under the storage conditions studied

Oil content: The oil content of the seeds was about the same for all types of storage and the same as at harvest. In some cases we found a small increase in oil content during the storage period.

Germinability: The germinability has almost always been higher in material swathed before threshing than in material directly threshed and stored without being artificially dried. The higher the moisture content of the seed at harvest and the higher the storage temperature the greater was the decrease in germinability.

Thousand kernel weight: The thousand kernel weight decreased a few per cent units but in some cases we found no decrease, in spite of four weeks storage at high moisture content in the seed. This indicates that the respiration losses in the material in most cases have been relatively small.

However, the changes in oil content and thousand kernel weight, especially concerning seeds with high moisture content stored at a high temperature, result in some losses of oil during storage.

Free fatty acids: In seeds with high moisture content stored at high temperature the content of free fatty acids increased one or two tenths of one per cent.

Conclusions

The investigation concerning the possibilities to influence the chlorophyll content in the oil from spring rape seed through the storing conditions is still in progress, but so far the results show that the chlorophyll content can be markedly reduced at temperatures of +10 to +20° C if the moisture content of the seeds is above 25 per cent. Most of the reduction obtained occurs within three days. The risk of great losses of oil or other products through respiration seems to be relatively small. But we have negative effects of other kinds. An increase in the presence of fungi can occur, as well as in the presence of an very unpleasant odour in the storage, especially if the container is not thoroughly aired. An increase of free fatty acids may also occur. The results are obtained with small samples in the laboratory and must be tested in full-scale experiments before we can judge their validity for practice.

References

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