July 2013

Project Report No. 514

Survey of current agronomic practices influencing free fatty acid content in oilseed rape during the 2011/2012 season

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1. Abstract

Introduction

- High levels of free fatty acids (FFAs) in rapeseed oil were a problem in 2012, particularly in Scotland. HGCA and oilseed merchants and processors have worked in partnership to conduct a grower survey and review crop quality.
- High levels of FFAs make oil unsuitable for human consumption and can also cause foaming in biofuels. Removing FFAs is a significant cost for processors and this is reflected in a lower price for growers.
- This research looks at how region, variety, cultivation method, harvest method, drying method and storage method affected free fatty acid levels in oilseed rape during harvest 2012.

Conclusions and recommendations

1. Although weather was a major factor in the increase of FFA in 2012, there are practical steps growers can take to minimise the risk.
2. Attention to detail should be paid, and oilseed rape should be handled after harvest in a similar way to malting barley or any seed crop
    a. Timeliness of harvest – this research has indicated that the time the oilseed rape crop is harvested can impact FFA content. Attention to detail regarding the interval between desiccation and harvest is required.
        i. If the crop is harvested too early, it is at risk of immature seeds
        ii. If the crop is harvested too late, it is at risk of pre-germination
        (Immature and pre-germinated seeds have been identified in the scientific literature as contributing to increased FFA content (Uppström *et al.*, 1995)*)*
    b. Drying temperature
        i. Care should be taken in selecting the temperature of the dryer
        ii. FFA content increases with an increase in dryer temperature
    c. Ventilation of the rapeseed has a significant impact on FFA content
        i. Rapeseed which was not ventilated recorded a higher FFA content
        ii. It is important that the crop is ventilated prior to drying, as any build-up of heat in the crop may significantly increase the risk of FFAs.
3. Varietal differences within the 2011/12 season have not been significant but ultimately more research is needed.

Further steps

- HGCA and the industry agree that it is important to invest further in FFA research
    - Potential varietal differences could be tested by analysis of Recommended Lists material at harvest.

It is proposed the survey is continued for a further two years to confirm findings. The survey must be extended to the whole of the UK and, where possible, include samples where FFA hotspots have been identified.

2. Introduction

Excessive levels of free fatty acids (FFAs) in oilseeds can lead to a decline in oilseed quality, altering its chemical properties and making them unsuitable for human consumption and causing foaming in biofuels. This results in a significant cost for processors, and growers can be financially penalised when FFA levels are recorded above 2%. This penalty is not standardised but is determined by the merchants and is often implemented on a sliding scale.

In 2012, FFA levels in Scotland rose above the 2% market requirements and a high proportion of growers received penalties. Although the problem was greatest in the north of the UK, it was not confined to these areas and pockets of high FFA levels were seen in England – particularly in areas of wet and heavy soils. However, 2012 is not a year in isolation; high FFA levels were also recorded in 2004 and 2007 and it is not unusual to see FFA levels exceed 5% each year. At present, it is unclear if these results are linked to agronomic practice.

Previous research into FFA content has primarily used Canadian varieties, and indicated that immature, damaged or germinated seeds can cause an increase in FFA levels (Uppström *et al*., 1995) and also that storage might be a factor due to the opportunity for oxidation and hydrolysis of fats (NRI, 1995). In 2003, HGCA conducted a survey of harvesting, drying and storage of oilseed rape, and results suggested that inappropriate drying temperatures resulted in burnt seeds with high FFA levels (HGCA Project Report 371).

The industry agree that it is important to invest in this problem and a partnership between HGCA and oilseed merchants have been investigating the FFA levels in rapeseed experienced in 2012. A survey was developed by the partners and distributed to the merchants' customers in order to identify if crop or rapeseed management influenced the FFA content in rapeseed. Key factors investigated were: crop production (variety choice, sow date, seed rate), crop management (fungicide and nitrogen application, harvesting) and rapeseed management (drying, storage).

3. Methods

The survey was distributed to the oilseed merchants' customers and collated and analysed by HGCA. Sixty-seven responses were received, and growers recorded FFA content ranging from 1.02% to 15.1% (Table 1). The majority of responses came from eastern regions of Scotland (88%), whilst a smaller proportion came from the north (12%) – reflecting the regions in Scotland where oilseed rape is grown.

The responses and the corresponding FFA levels received suggest that the survey is highly self-selective, since there is a restricted number of responses from each region, and the range of FFA

is not representative as only growers with problems this year would be more inclined to respond to the survey. Findings from the survey should therefore be treated with caution.

Table 1. Summary of survey respondents

	Number of Responses	Lowest FFA Recorded	Highest FFA Recorded	Mean FFA	Median FFA
Scotland – North	59	1.02%	15.10%	5.73%	5.40%
Scotland – East	8	1.40%	9.54%	3.35%	2.40%
Scotland – West	0	0	0	0	0
Other UK	0	0	0	0	0

4. Results

4.1. Variety choice

Previous research linking agronomic practices to FFA content has identified differing FFA levels in Canadian varieties of oilseed rape (May *et.al*., 1994). The FFA tests were taken in a bulk of varieties, so it is not possible to detect individual variety differences from the data recorded in this survey. Variety type, flowering time and maturity (as defined by the 2013/14 HGCA Recommended List) were investigated from those bulked samples where the varieties tested fell into the same category.

Significant differences in FFA content were not observed in flowering time and variety type and it can be concluded that these varietal traits did not impact FFA content in this season. However, a significant difference was observed in the maturity of the variety. The survey indicated that later maturing varieties possessed a lower FFA content, and so this may have been a factor influencing FFA content in this season (Figure 1). Little is known about the individual varieties since these results are from bulked samples, although there is significant support of testing for varietal differences through the Recommended List trials.

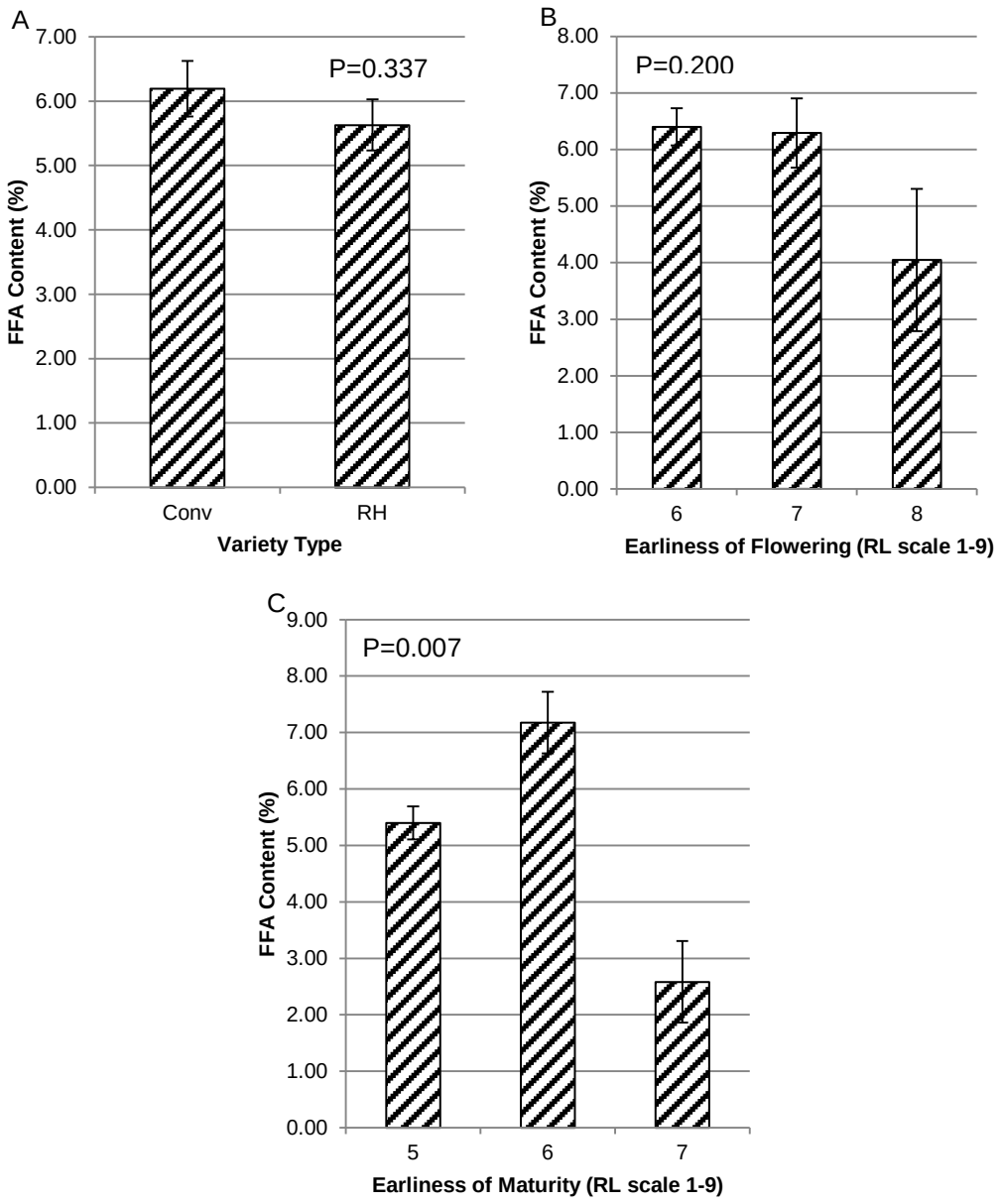

Figure 1. (A) Average FFA content recorded in conventional (conv) and restored hybrid (RH) varieties as defined by the 2013/14 HGCA Recommended List. (B) Average FFA content recorded in varieties categorised by flowering time as defined by the 2013/14 HGCA Recommended List. (C) Average FFA content recorded in varieties categorised by maturity as defined by the 2013/14 HGCA Recommended List.

4.2. Sow date

Growers were asked the date their 2011/2012 oilseed rape crop was sown, and were classed into three periods; Early (pre 1 September), Medium (1–10 September), and Late (post 10 September). All responses were received from winter sown oilseed rape crops.

The majority of growers sowed their crop during the early part of the growing season, although growers would have been restricted on timing by weather conditions. Those crops sown later in the planting season had a higher FFA content than those sown earlier (Figure 2), which is consistent

with research conducted in Canadian varieties (May *et.al*., 1994), however, there were no significant differences in FFA content observed. Conclusions cannot be drawn from this one year's data, and should be followed up in future surveys and analysed together with weather data. Early indications suggest the majority of the Scottish 2012/13 oilseed rape crop would have been drilled in the week commencing 1 September, due to good weather in this period.

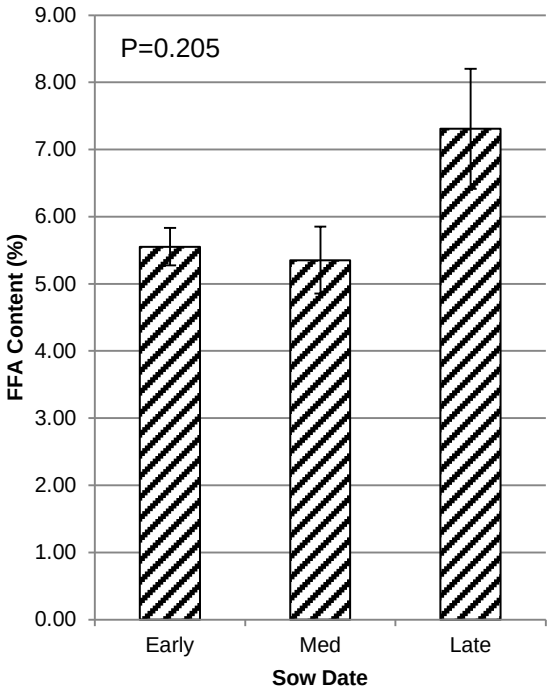

Figure 2. Average FFA content recorded in rapeseed samples at varying sow date – early (pre 1 September), medium (1–10 September) and late (post 10 September)

4.3. Seed rate

FFA levels have been found to be higher in rapeseed sampled from the branches of the plant than those sampled from the main stem, and Canadian research has indicated that reducing seed rate increased levels of FFA, consistent with increased branching (May *et.al*., 1994).

The survey did not observe any significant differences between seed rate used (Figure 3), therefore no conclusions can be drawn over its effect on FFA content in this season.

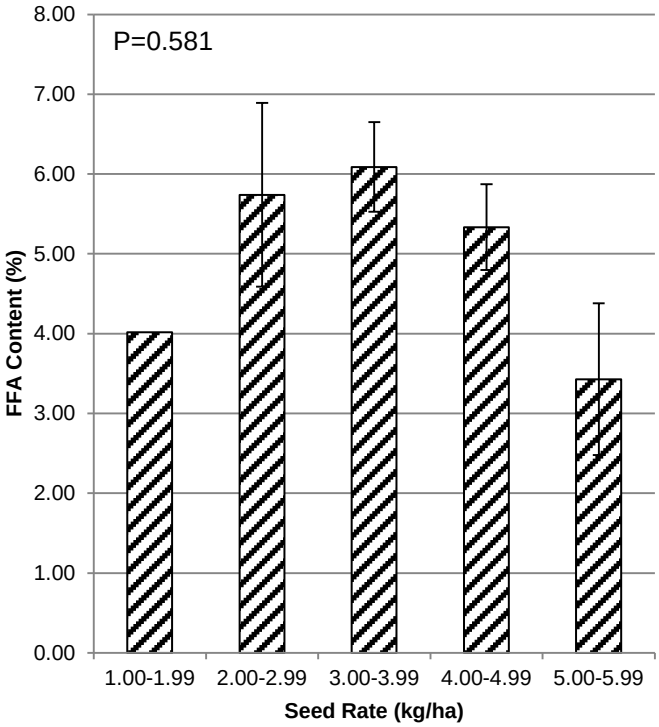

Figure 3. Average FFA content recorded in rapeseed samples at varying seed rate

4.4. Fungicide applications

The management of fungicide sprays were investigated for effect on FFA content. In addition to the data displayed, all of the survey respondents used a spring fungicide.

All growers surveyed were providing optimal fungicide applications; all were applying spring fungicides, and at least one petal spray application. However, the survey results have indicated that fungicide applications did not significantly affect FFA content in this season, since the application of an autumn fungicide, the number of petal spray application and the fungicide water volume used did not significantly alter FFA content of the rapeseed samples (Figure 4).

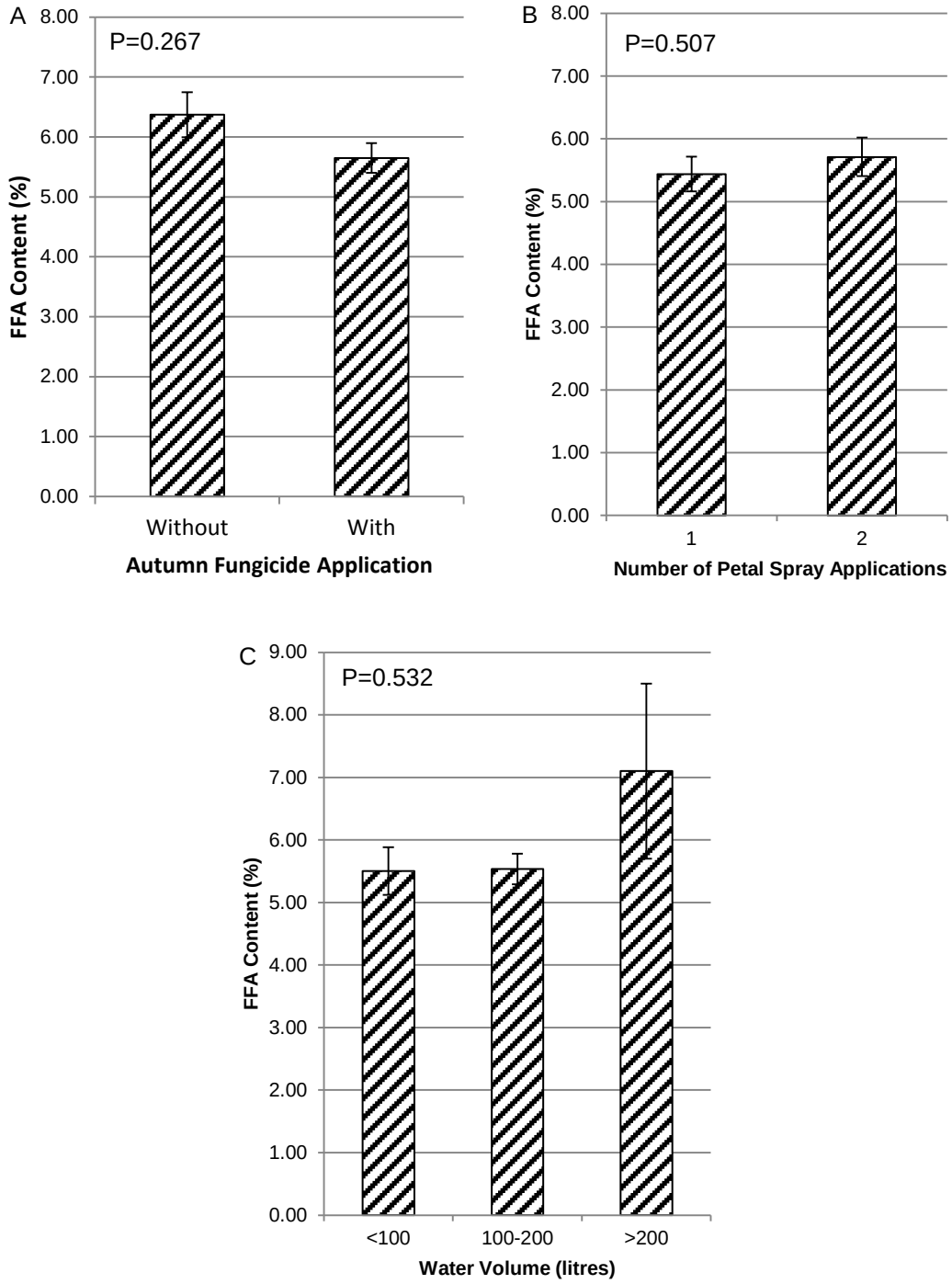

Figure 4. (A) Average FFA content recorded in rapeseed samples with and without an autumn fungicide application. (B) Average FFA content recorded in rapeseed samples with one or two petal spray applications. (C) Average FFA content recorded in rapeseed samples at varying fungicide water volumes.

4.5. Nitrogen

A late nitrogen application, at post green bud stage, did not significantly affect FFA content in the rapeseed sampled by the respondents in the survey (Figure 5). Therefore, from the data collected in this season, it cannot be concluded that nitrogen influenced FFA content.

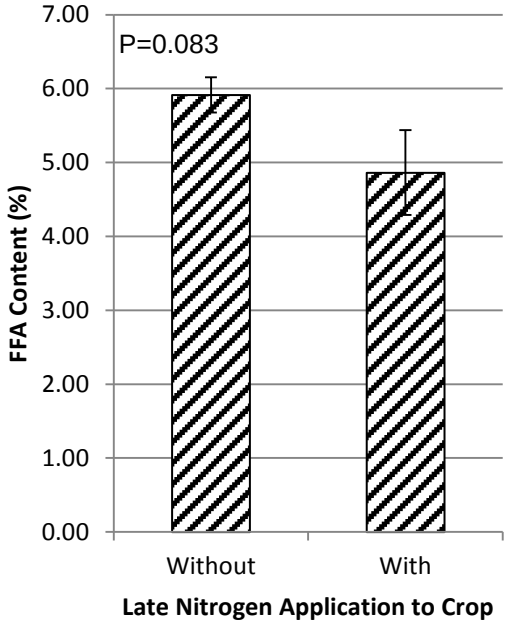

Figure 5. Average FFA content in rapeseed samples with and without a late nitrogen application (post green bud stage).

4.6. Harvest

Agronomic practices around the harvest and handling of the rapeseed were investigated within the survey.

4.6.1. Harvest date

Crops harvested early and late showed an increase in FFA content compared to those harvested during the middle of the harvest season, and a significant difference in FFA content and harvest date was observed (Figure 6). Those harvested early are likely to have immature seeds, a factor which has been identified as increasing FFA content, and late harvested oilseed rape are likely to have high FFA levels due to pre-germination (Uppström *et.al.*, 1995).

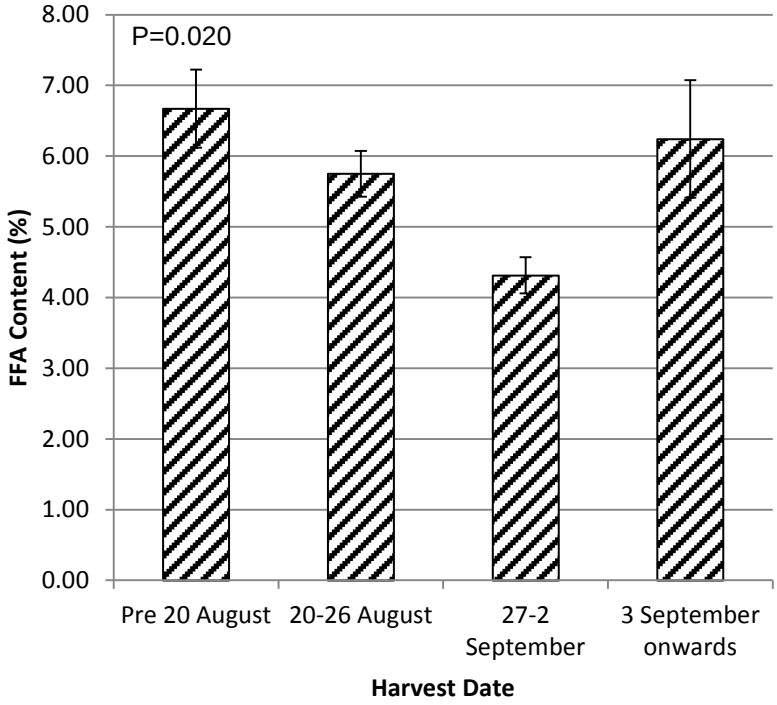

Figure 6. Average FFA content in rapeseed samples at varying harvest date.

4.6.2. Harvest method

Two main oilseed rape harvesting techniques are desiccation and swathing, and results from the survey have indicated that desiccating the crop can results in a significantly higher FFA content of the rapeseed, with crops most at risk when crops are desiccated with diquat (Figure 7). However, although significant differences in FFA content were observed between these harvest methods, conclusions cannot be drawn as this is typically a regional choice – most swathing would occur in the northern regions, where FFA levels were lower.

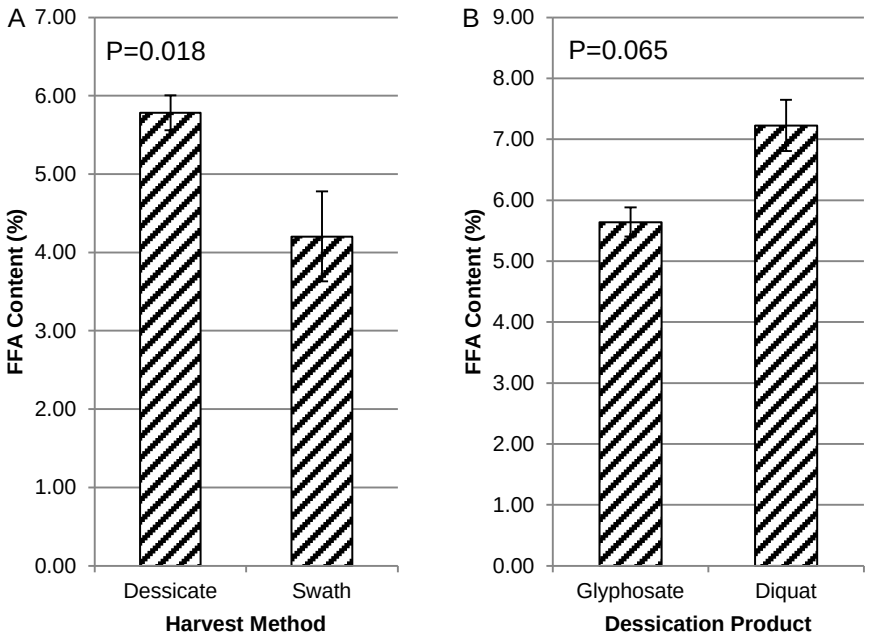

Figure 7. Average FFA content in rapeseed samples using (A) varying harvest method and (B) varying methods of desiccation.

4.6.3. Drying

Attack by water in the presence of the lipase enzyme splits the FFA away from the triglyceride – this hydrolysis is accelerated by the presence of moulds, and therefore correct drying can be influential in managing FFA content.

Although no significant differences in FFA content were identified in those samples found at 10–25% moisture content, no samples were recorded below 10% (Figure 8). Fungi, moulds and spoilage occur at moisture contents above 12%, and so FFA content at these moisture levels would be expected to be high. The survey results suggest that FFA content increases with moisture content, but further data is required to confirm this finding.

Significant differences are observed in FFA content and the type of drier used, as the survey has indicated that samples dried in a continuous flow drier contained the highest FFA and those processed in a tray drier contained the least FFA (Figure 9). However, there is great variation between driers within the same group (such as differing tray depths in the tray driers), and potential overlap between the groups of dryers. Conclusions can therefore not be drawn from this data, and drying temperature should be investigated further.

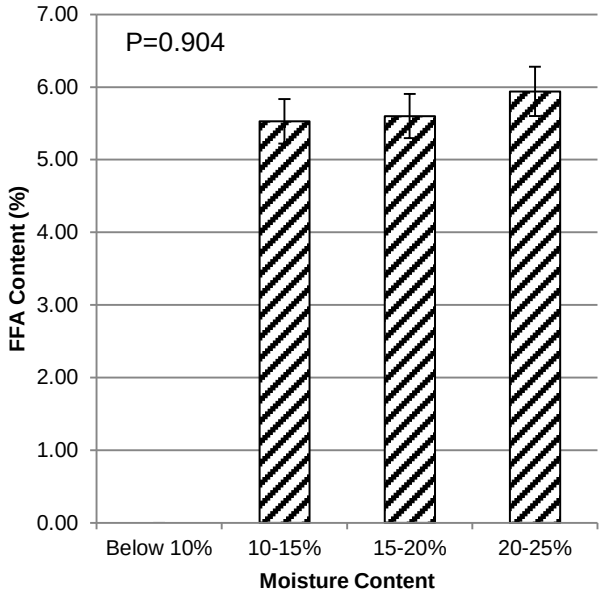

Figure 8. Average FFA content in rapeseed samples at varying moisture content at harvest.

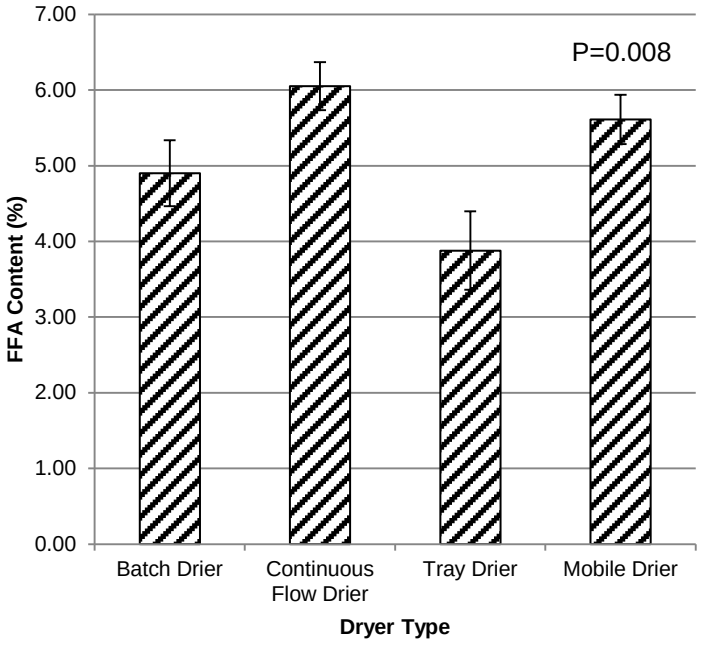

Figure 9. Average FFA content in rapeseed samples using different drying methods.

A trend of increased FFA content with higher drying temperatures was observed (Figure 10), although a significant difference was not seen between the drying temperatures. Further data from a continuation of the survey would confirm these points.

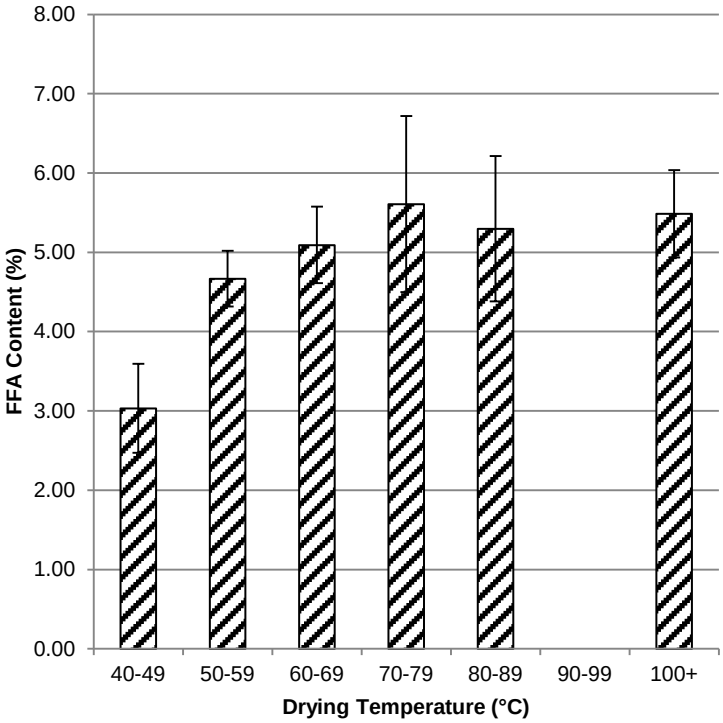

Figure 10. Average FFA content in rapeseed samples dried at different temperatures.

Ventilation of the rapeseed had a significant effect on FFA content (Figure 11). Seeds which were ventilated had an average of 1.5% less FFA content than those which were not.

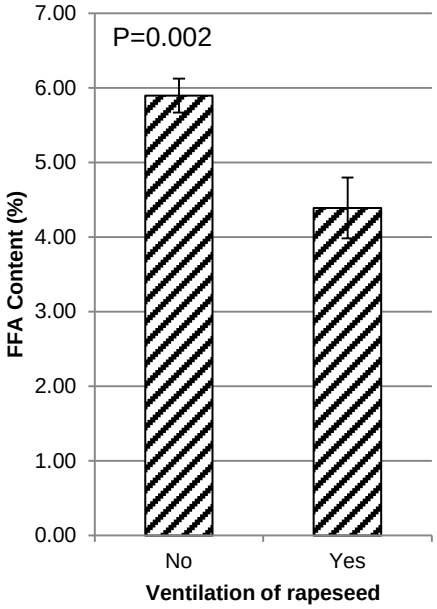

Figure 11. Average FFA content in rapeseed samples with and without ventilation.

5. Conclusions

The conclusions drawn from this survey should be treated with caution, due to the small sample size and self-selective nature of respondents. However, this study does give indications of current agronomic practices which have influenced FFA in rapeseed – particularly in regard to the timeliness of harvest and seed handling. Time of harvest has influenced FFA content, since immature grains and pre-germinated grains, which are found during an early or late harvest, contain an increased FFA level and seed handling has been shown to be influential in FFA content, in particular careful selection of drying temperature and ventilation of the rapeseed. The conclusions drawn highlight the care which needs to be taken during these stages of rapeseed production.

Overall, these results have indicated that attention to detail should be paid, and oilseed rape should be treated as any high value seed crop. Varietal differences within the 2011/12 season could not be confirmed from this single year data, and so further research will need to be conducted in order to test these potential varietal differences.
It is proposed the survey is continued for a further two years to confirm findings. The survey must be extended to the whole of the UK and, where possible, include samples where FFA hotspots have been identified.

6. References

HGCA Project Report 371 (2005) - Survey of current harvesting, drying and storage practices with oilseed rape.

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